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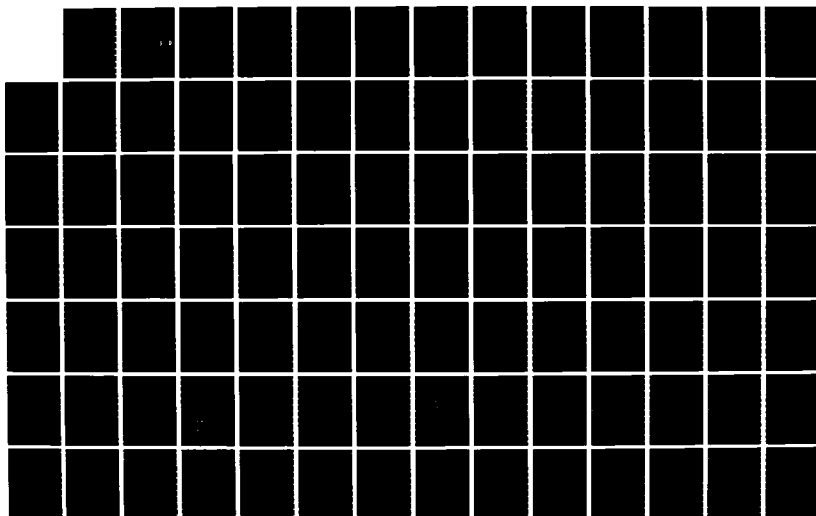
AIRCRAFT AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS
PROGRAM SYMPOSIUM H. (U) NAVAL SAFETY CENTER NORFOLK VA
1981

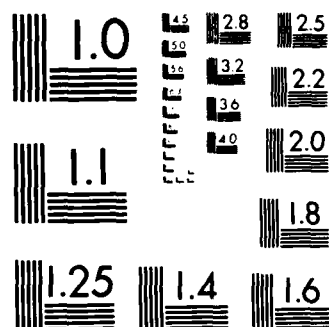
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DTIC ACCESSION NUMBER

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AIRCREW AUTOMATED ESCAPE
SYSTEMS (AAES)

INVENTORY

DATA ANALYSIS PROGRAM SYMPOSIUM

VOL. IV

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AD-A171 659

**AIRCREW AUTOMATED ESCAPE SYSTEMS
(AAES)**

**DATA ANALYSIS PROGRAM
SYMPOSIUM**

VOL IV

(COPIES OF VISUAL PRESENTATION AIDS & ADDITIONAL INFORMATION)

Presented by:

**NAVAL AIR SYSTEMS COMMAND
NAVAL SAFETY CENTER
NAVAL WEAPONS ENGINEERING SUPPORT ACTIVITY**

**APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION UNLIMITED**

**6,7,8 OCTOBER, 1981
NAVAL SAFETY CENTER
NORFOLK, VIRGINIA**

AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES)

DATA ANALYSIS PROGRAM SYMPOSIUM

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**6,7,8 OCTOBER, 1981
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NORFOLK, VIRGINIA**



DEPARTMENT OF THE NAVY
NAVAL SAFETY CENTER
NAVAL AIR STATION
NORFOLK, VIRGINIA 23511

IN REPLY REFER TO:

122:gc
3750
Ser 4223
4 September 1981

From: Commander, Naval Safety Center
To: Distribution

Subj: Automated Airborne Escape Systems (AAES) Symposium

Encl: (1) Agenda for subject symposium

1. At the request of the Chief of Naval Operations and with the cooperation and support of Commander, Naval Air Systems Command, Commander, Naval Safety Center, will co-host a two-day symposium to review selected topics associated with Automated Airborne Escape Systems (AAES).
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J. C. Steele
T. C. STEELE

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LTOOL LAMGEMAR, SWEDISH EMBASSY
INSTITUTE OF AVIATION MEDICINE, RN
MINISTRY OF DEFENSE, UK
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AFPRO ST LOUIS MO
AFPRO SEATTLE WA
AFPRO FT WORTH TX
AFPRO FARMINGDALE, NY
GENERALDYNAMICS
APPLIED COMBUSTION TECHNOLOGY
MANTECH INTERNATIONAL CORP

AGENDA DAY 1

0800-0850	Registration
0900-0915	Opening Remarks - Welcome
	RADM T. C. Steele
0915-0945	Introduction of Host Reps
	Area Orientation
0945-1000	Break
1000-1050	AAES Data System Program Introduction
1100-1150	Review of AAES Use and Non-use
1200-1330	Lunch Break
1330-1420	Through vs Jettison Canopy Injuries
1430-1520	Helmet Retention/Loss Factors

AGENDA DAY 2

0900-0950	Flail/Tumbling Factors
1000-1150	In-Service System Reliability
1200-1330	Lunch Break
1330-1420	Overwater Survivability
1430-1520	Aircrew Size/Anthropometry
1530-1620	Expected Impact of AAES Data System Usage

AGENDA DAY 3

To be used as necessary based on progress
during days 1 and 2

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1. Introduction to AAES Data System Program NAVAIR/NAWESA
Objectives
Interface NAVSAFECEN/NAVAIR
Present Status - Future Plans
Constraints
2. Review of historical use and non-use of AAES NAVSAFECEN/NAVAIR
Results: Survivability
Trends in Usage Rates
Non-survived Ejection Cause Factors
Usage Conditions
AAES non-use trends
Success Criteria
3. Through-canopy vs Jettisoned-canopy Injuries NAVAIR/NAVSAFECEN
Vertebral
Upper-lower limbs
Head/neck
4. Helmet Retention/Loss Factors NAVAIR/NAVSAFECEN
Vertebral Injury
Varying levels of consciousness
Head/Neck Injury
5. Ejection Flail-tumbling Factors NAWESA/NAVAIR
As a function of airspeed
As a function of system design
As a function of Escape initiation method

6. In-service Reliability NAVWESA/NAVAIR

Ejections attempted but not accomplished

Other failure/malfunction modes

7. Ejection Survivability in Low Altitude Overwater Environment NAVSAFECEN/
NAVAIR

. Land vs Water Survival

. Overwater Fatalities

. Parachute/RSSK Divestment and LPA Inflation Variables

8. Aircrew Restraint Factors NAVSAFECEN/NAVAIR

. Negative "G" Environment

. Research on "G" Restraint Systems

9. Expected Impact of AAES Data System Program NAVAIR/NAVWESA

. Short Range

. Long Range

PROPOSED ATTENDEES

U. S. NAVY; Representation from:

OPNAV - 05F, 506N
CHNAVMAT
COMNAVAIRSYSCOM
NAVAIRDEVCON
NAWPNCEN CHINA LAKE
BUMED
MONTEREY
CNET
ONR
NAVAIRTESTCEN
NAVORDSTA
NAMRL PNCLA
NAMI PNCLA
NAVAL BIODYNAMICS LAB
NAVAIREWORKFACS (6)
TYCOM - Safety; Flight Surgeons; Physiologists
OPTEVFOR

USAF; Representation from:

NORTON AFB
WRIGHT PATTERSON AFB
BROOKS AFB
ANDREWS AFB
KELLEY AFB

ARMY; Representation from:

FORT RUCKER
ST LOUIS

NASA

LANGLEY AFB
MANNED SPACE CENTER

CONTRACTORS

PRIME AIRFRAME

Grumman; Boeing; Vought; Douglas; McDonnell; Republic; Fairchild-Miller; Lockheed; Convair; Martin-Baker LTD, U.K.

OTHERS

Teldyne Ryan; Stencel Aero Engineering Corp.; Pacific Scientific; Talley; Biotechnology; Humanoid Systems; Dayton T. Brown; East-West Industries; Explosive Technology; Space Ordnance Systems; Person-System Integration; Advanced Logistics Management Inc.; University of Cincinnati; Wayne State University; University of Southern California

FOREIGN GOVERNMENTS (having similar AAES)

CANADA

GREAT BRITAIN

FEDERAL REPUBLIC OF GERMANY

CLASSIFICATION

UNCLASSIFIED

05 NOV 1980 PAGE 1 OF 3

ADDRESSEE Director, Naval Weapons Engineering Support Activity Systems Analysis Dept. (ESA-31) Washington Navy Yard, Wash.D.C. 20374	AIRTASK NO A512-512C/184-4/1512-000-055 WORK UNIT NO A5312B-04 EFFORT LEVEL NORMAL CLASSIFICATION OF AT NO UNCLASSIFIED	AMEND NO AMEND NO
NAVAIR PROJECT ENGINEER Mr. Frederick C. Guill AV 222-7486	ICE AIR-531C	

1. The ~~XXXXXX~~ WORK UNIT ASSIGNMENT described below is assigned in accordance with the indicated effort level and schedule. Fund-
ing authorization for ~~XXXXXX~~ will be provided in separate correspondence. If this ~~XXXXXX~~ WORK UNIT ASSIGNMENT cannot be accom-
plished as assigned, advise the NAVAIR HQ cognizant code. No work beyond the planning phase will be accomplished unless the addressee
has funds in hand or written assurance thereof.

2. Cancellation, References and/or Enclosures.

Cancellation: Work Unit A5312B-04 dated 13 Dec 1979 and subsequent amendments
under AIRTASK A512-512C/184/0512-000-055 amend. 1.

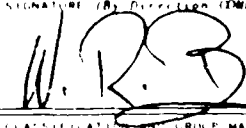
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Projects 10 October 1980
(2) Schedule

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b. Purpose. To establish a systematic investigation of in-service AAES data,
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Reports of Aircraft Accidents, and Naval Air Rework Facility Data Systems, to identify
for potential corrective action the many daily low-grade problems which contribute to
the general lowering of AAES in-service reliability and cause the general worsening of
AAES in-service maintainability.

c. Background. At present there exist special arrangements for investigating
and correcting spectacular AAES in-service problems, particularly those which cause
fatalities. This effort is intended for reviewing the pervasive non-spectacular
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manifest themselves in fatalities, serious injuries and/or very great difficulties
experienced by the ejectee, which under slightly different conditions could have
caused serious injuries. Some problems also manifest themselves in increased

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DEPARTMENT OF THE NAVY
NAVAL SAFETY CENTER
NAVAL AIR STATION
NORFOLK, VIRGINIA 23511

IN REPLY REFER TO:

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INSTITUTE OF AVIATION MEDICINE, RN
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Varying levels of consciousness
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 - Ejections attempted but not accomplished
 - Other failure/malfunction modes
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 - . Land vs Water Survival
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 - . Parachute/RSSK Divestment and LPA Inflation Variables
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 - . Long Range

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U. S. NAVY; Representation from:

OPNAV - 05F, 506N
CHNAVMAT
COMNAVAIRSYSCOM
NAVAIRDEVCON
NAVPENCEN CHINA LAKE
BUMED
MONTEREY
ONET
ONR
NAVAIRTESTCEN
NAVORDSTA
NAMRL PNCLA
NAMI PNCLA
NAVAL BIODYNAMICS LAB
NAVAIREWORKFACS (6)
TYCOM - Safety; Flight Surgeons; Physiologists
OPTEVFOR

USAF; Representation from:

NORTON AFB
WRIGHT PATTERSON AFB
BROOKS AFB
ANDREWS AFB
KELLEY AFB

ARMY; Representation from:

FORT RUCKER
ST LOUIS

NASA

LANGLEY AFB
MANNED SPACE CENTER

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OTHERS

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Talley; Biotechnology; Humanoid Systems; Dayton T. Brown; East-West
Industries; Explosive Technology; Space Ordnance Systems; Person-
System Integration; Advanced Logistics Management Inc.; University of
Cincinnati; Wayne State University; University of Southern California

FOREIGN GOVERNMENTS (having similar AAES)

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FEDERAL REPUBLIC OF GERMANY

CLASSIFICATION

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05 NOV 1980 PAGE 1 OF 3

ADDRESSEE Director, Naval Weapons Engineering Support Activity Systems Analysis Dept. (ESA-31) Washington Navy Yard, Wash.D.C. 20374		AIRTASK NO. A512-512C/184-4/1512-000-055	AMEND NO.
NAVAIR PROJECT ENGINEER Mr. Frederick C. Guill AV 222-7486		WORK UNIT NO. A5312B-04	AMEND NO.
CODE AIR-531C		EFFORT LEVEL NORMAL	
		CLASSIFICATION OF AT/WU UNCLASSIFIED	

1. The ~~XXXXXX~~ WORK UNIT ASSIGNMENT described below is assigned in accordance with the indicated effort level and schedule. Fund-
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caused serious injuries. Some problems also manifest themselves in increased

SIGNATURE (By Director COMNAVAIR) <i>W. R. B. Burris</i>	DATE 11/5/80
CLASSIFICATION AND GROUP MARKING UNCLASSIFIED	

Previous issues of this form are obsolete.

W.U. A5312B-04
AIRTASK A512-512C/184-4/1512-000-055

maintenance efforts and costs and/or increased hazards to maintenance personnel. Since there at present is no systematic review of in-service AAES data, there is no valid method of identifying AAES in-service problems deserving management attention short of awaiting death, serious injury or major complaints. Thus NAVAIR is forced into a "squeaky wheel" reaction mode of operation versus the more desirable mode of allocating resources based on a continuous analysis of the total AAES in-service experience.

d. Detailed Requirements/Cost Estimates. \$90.0 K for FY-81 in support of applicable projects listed on enclosure (1) Priority List, to be obligated quarterly as follows: first quarter \$30.0 K, second quarter \$30.0 K, third quarter \$30.0 K. Program element - 78012N (O & MN).

Continue establishment of a system for the systematic review of such sources of AAES in-service data as 3-M Systems, Unsatisfactory Reports, Medical Officer Reports of Aircraft Accidents, and Naval Air Rework Facility data systems, in a manner designed to identify and assess the significance of the many commonly occurring in-service problems affecting AAES in-service reliability and maintainability. The system outputs shall be structured to provide data of assistance to NAVAIR Headquarters in the management of the scarce AAES resources; e.g., problems experienced, frequency of occurrence, experience severity, potential severity, and range of activities and/or AAES experiencing the problems. Once established and documented the system(s) can be integrated into regular reporting systems to assure regular, early notification to NAVAIR Headquarters concerning in-service problems being experienced and should assist considerably in the identification of causes and development of remedial actions. In addition, perform specific analytical tasks of high priority as assigned.

e. Detailed Program Plan. Not applicable.

f. Field Activity Contact. Mr. G. Opresko, NAVWESA (ESA-31).

g. Headquarters Technical Support. None.

4. Schedule. See Enclosure (2).

5. Reports and Documentation.

a. Reports.

(1) Upon completion of each task, present data and findings in letter-type reports to NAVAIR Headquarters (AIR-531).

(2) A semi-annual program review shall be held at NAVAIR in February and August with NAVAIR publishing a report of findings in March and September.

UNCLASSIFIED

W.U. A5312B-04
AIRTASK A512-512C/184-4/1512-000-055

(3) NAVWESA shall report to the Commander, Naval Air Systems Command (AIR-512C) the man years and associated cost, cost of materials, travel and cost of contracts awarded by NAVWESA for this project. This report shall be submitted 1 May 1981 and 1 November 1981 for final status.

b. Requirements for Future Planning Information. Prepare and submit to NAVAIRHQ (AIR-531) for approval, a letter-type project plan. The primary effort shall be for establishment of baseline data to aid in subsequent identification of trends and specific problems. Subsequent tasks shall be for extending previous analytical techniques and data sources investigating efforts to identify specific AAES in-service reliability and maintainability problems.

6. Contractual Authority. Contracts to perform all or portions of the Work Unit are hereby authorized within the funding indicated by the Work Unit cost estimate.

7. Source and Disposition of Equipment. Not applicable.

8. Aircraft Requirements. None.

9. Status of Applicable Funds. Funds for this Work Unit will be provided separately.

10. Security Classification. All prescribed work under this Work Unit is unclassified. In performing the prescribed work, access to information which is classified and/or to areas containing classified equipment may be required. Any reference to such classified material shall be in accordance with the applicable materials security classification. Particularly, reference to information concerning survivability/vulnerability shall be classified in accordance with OPNAVINST. C5513.2A, Encl. (63); OPNAVINST. S5513.8, Encl. (7).

Copy to:

Addressee (3)
NAVMATDATASYSGRU, Morgantown, W.Va. 26505
NAVAIRDEVCON (CSD), Warminster
NAVAIRTESTCON (SY-70), PAXRIV
NAVORDSTA (Code 5123), Indian Head
NAVORDSTA (Code 515), Indian Head
NAVWPNCEN, China Lake (Code 64)
NAVSAFECEN, Norfolk
COMNAVAIRPAC, North Island
CGFMFLANT
CGFMFPAC
NAVPLANTREPO, Bethpage
NAVPLANTREPO, Dallas
NAVPLANTREPO, Burbank
NAVPLANTREPO, Long Beach
AFPRO, St. Louis
DCASMA (DCRA-GACB), Marietta

UNCLASSIFIED

JAN 1969 - DEC 1979

[illegible]

[illegible]

EXCLUDING AV 8A & TA 7)

TOTAL EJECTS 237
SURVIVORS 179
INJURED SURVIVORS 155

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JANUARY 1969 - DECEMBER 1979

[illegible]

FATAL INJURY CITATIONS/U.S. NAVY/EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT AND INADVERTENT
THROUGH-THE-CANOPY
(EXCLUDING AV-8A & TA-7)

JANUARY 1969 - DECEMBER 1979

FATALITIES 58

INJURY DIAGNOSIS	BODY PART INJURED	INJURY DIAGNOSIS																									
		103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
HEAD/NECK	HEAD/NECK	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
SKULL (01)	SKULL (01)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
FACE (02)	FACE (02)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
EYE (03)	EYE (03)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NOSE (04)	NOSE (04)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NECK (05)	NECK (05)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
ARMS	ARMS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
UPPER ARM (14)	UPPER ARM (14)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
LOWER ARM (15)	LOWER ARM (15)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
WIST (16)	WIST (16)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
ELBOW (21)	ELBOW (21)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
HAND (17)	HAND (17)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
LEGS	LEGS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
UPPER LEG (10)	UPPER LEG (10)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
LOWER LEG (11)	LOWER LEG (11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
KNEE (21)	KNEE (21)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
ANKLE (12)	ANKLE (12)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
FOOT (13)	FOOT (13)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
TRUNK	TRUNK	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
SHOULDER (06)	SHOULDER (06)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
TWIST (07)	TWIST (07)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
ABDOMEN (07)	ABDOMEN (07)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
PELVIS (08)	PELVIS (08)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
THIGH (18)	THIGH (18)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
LEG (19)	LEG (19)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
BACK (18)	BACK (18)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
BUTTOCKS (09)	BUTTOCKS (09)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
INTERNAL ORGANS	INTERNAL ORGANS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
HEART (20)	HEART (20)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
LUNGS (20)	LUNGS (20)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
OTHER (19)	OTHER (19)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
MULTI BODY PARTS (20)	MULTI BODY PARTS (20)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
TOTAL BODY (20)	TOTAL BODY (20)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

JAN 1969 - DEC 1979

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[illegible]

JANUARY 1969 - DECEMBER 1979

[illegible]

JANUARY 1969 - DECEMBER 1979

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JAN 1969 - DEC 1979

[illegible]

[CODES: 1 & 5]

JAN 1969 ~ DEC 1979

TOTAL EJECTS: 160
FATALITIES: 19
RECOVERED: 13 LOST:

[illegible]

ICODES: 1 & 5)

JAN 1969 - DEC 1979

TOTAL EJECTEES: 124
SURVIVORS: 110
UNINJURED SURVIVORS: 6

[illegible]

(CODES: 1 & 5)

JAN 1969 -- DEC 1979

TOTAL EJECTEES: 124
FATALITIES: 14
RECOVERED: 10 LOST

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JAN 69 - DEC 79

TOTAL EJECTEES: 41
SURVIVORS: 31
UNARMED SURVIVORS: 28

[illegible]

(CODES: 1 & 5)

JAN 1969 - DEC 1979

TOTAL EJECTEES 43
SURVIVORS 40
INJURED SURVIVORS 30

INJURY DIAGNOSIS		INJURED SURVIVORS 30		INJURY DIAGNOSIS	
BODY PART INJURED	INJURY	INJURED SURVIVORS 30	INJURY	INJURED SURVIVORS 30	INJURY
HEAD/NECK	SKULL (01)		SKULL (01)		SKULL (01)
	FACE (02)		FACE (02)		FACE (02)
	NOSE (03)		NOSE (03)		NOSE (03)
	NECK (04)		NECK (04)		NECK (04)
ARMS	UPPER ARM (14)		UPPER ARM (14)		UPPER ARM (14)
	LOWER ARM (15)		LOWER ARM (15)		LOWER ARM (15)
	Wrist (16)		Wrist (16)		Wrist (16)
	HAND (17)		HAND (17)		HAND (17)
LEGS	UPPER LEG (10)		UPPER LEG (10)		UPPER LEG (10)
	LOWER LEG (11)		LOWER LEG (11)		LOWER LEG (11)
	ANKLE (12)		ANKLE (12)		ANKLE (12)
	FOOT (13)		FOOT (13)		FOOT (13)
TRUNK	SHOULDER (05)		SHOULDER (05)		SHOULDER (05)
	THORAX (06)		THORAX (06)		THORAX (06)
	ABDOMEN (07)		ABDOMEN (07)		ABDOMEN (07)
	PELVIS (08)		PELVIS (08)		PELVIS (08)
	GRUIN (23)		GRUIN (23)		GRUIN (23)
	BACK (18)		BACK (18)		BACK (18)
	BUTTOCKS (09)		BUTTOCKS (09)		BUTTOCKS (09)
INTERNAL ORGANS	HEART (19)		HEART (19)		HEART (19)
	LUNGS (20)		LUNGS (20)		LUNGS (20)
	OTHER (19)		OTHER (19)		OTHER (19)
MULTI BODY PARTS (20)					
TOTAL BODY (00)					

(CODES: 1 & 5)

JAN 1969 - DEC 1979

TOTAL EJECTES: 43
FATALITIES: 3
LOST: 1 RECOVERED: 2

- 38 -

JAN 89 - DEC 79

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JAN 1969 - DEC 1979

TOTAL SUBJECTS: 88
SURVIVORS: 53
KILLED SURVIVORS: 43

INJURY DIAGNOSES		HEAD/NECK		BODY PART INJURED		INJURY DIAGNOSES	
APPLIATION	AVULSION	DECRYSTATION	EVISCERATION	TRANSECTION	EXTREMITY AMPUTATION	TRANSECTION	COMMINUTED FRACTURE (08)
001	002	003	004	005	006	007	008
009	010	011	012	013	014	015	016
017	018	019	020	021	022	023	024
025	026	027	028	029	030	031	032
033	034	035	036	037	038	039	040
041	042	043	044	045	046	047	048
049	050	051	052	053	054	055	056
057	058	059	060	061	062	063	064
065	066	067	068	069	070	071	072
073	074	075	076	077	078	079	080
081	082	083	084	085	086	087	088
089	090	091	092	093	094	095	096
097	098	099	100	101	102	103	104
105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136
137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152
153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176
177	178	179	180	181	182	183	184
185	186	187	188	189	190	191	192
193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208
209	210	211	212	213	214	215	216
217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232
233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248
249	250	251	252	253	254	255	256
257	258	259	260	261	262	263	264
265	266	267	268	269	270	271	272
273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304
305	306	307	308	309	310	311	312
313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328
329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344
345	346	347	348	349	350	351	352
353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368
369	370	371	372	373	374	375	376
377	378	379	380	381	382	383	384
385	386	387	388	389	390	391	392
393	394	395	396	397	398	399	

JAN 1969 - DEC 1979

[illegible]

(CODES: 1 & 5)

JAN 1969 - DEC 1979)

TOTAL EJECTEES: 30
SURVIVORS: 26
INJURED SURVIVORS: 23

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TOTAL EJECTEES: 38
FATALITIES: 12
RECOVERED: 7 LOST: 5

[illegible]

JAN 1969 -- DEC 1979

LECTURES: 122

[illegible]

JAN 1969 - DEC 1979

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MK GRUJA SURVIVOR INJURY CITATIONS/U.S. NAVY/EJECTIONS ACCOMPLISHED CLEAR OF AIRCRAFT & INADVERTENT

(CODES: 1 & 5)

JAN 1969 - DEC 1979

TOTAL EJECTS. 67
 SURVIVORS. 56
 INJURED SURVIVORS. 38

INJURY DIAGNOSIS		HEAD/NECK		ARMS		LEGS		TRUNK		INTERNAL ORGANS		MULTI BODY PARTS/208		TOTAL BODY 000	
INJURY	DIAGNOSIS	HEAD/NECK	ARMS	LEGS	TRUNK	INTERNAL ORGANS	MULTI BODY PARTS/208	TOTAL BODY 000	INJURY	DIAGNOSIS	HEAD/NECK	ARMS	LEGS	TRUNK	INTERNAL ORGANS
101	SKULL 001	1													
102	FACE 002														
103	EYE 003														
104	NOSE 004														
105	NECK 005														
106	UPPER ARM 106														
107	LOWER ARM 107														
108	ELBOW 108														
109	WRIST 109														
110	HAND 110														
111	UPPER LEG 111														
112	LOWER LEG 112														
113	ANKLE 113														
114	FOOT 114														
115	SHOULDER 104														
116	THORAX 006														
117	ABDOMEN 007														
118	PELVIS 008														
119	GENITAL 009														
120	BACK 118														
121	BUTTOCKS 008														
122	INTERNAL ORGANS														
123	HEART 124														
124	LUNGS 125														
125	OTHER 116														
126	MULTI BODY PARTS/208														
127	TOTAL BODY 000														
128	SKULL 001														
129	FACE 002														
130	EYE 003														
131	NOSE 004														
132	NECK 005														
133	UPPER ARM 106														
134	LOWER ARM 107														
135	ELBOW 108														
136	WRIST 109														
137	HAND 110														
138	UPPER LEG 111														
139	LOWER LEG 112														
140	ANKLE 113														
141	FOOT 114														
142	SHOULDER 104														
143	THORAX 006														
144	ABDOMEN 007														
145	PELVIS 008														
146	GENITAL 009														
147	BACK 118														
148	BUTTOCKS 008														
149	INTERNAL ORGANS														
150	HEART 124														
151	LUNGS 125														
152	OTHER 116														
153	MULTI BODY PARTS/208														
154	TOTAL BODY 000														
155	SKULL 001														
156	FACE 002														
157	EYE 003														
158	NOSE 004														
159	NECK 005														
160	UPPER ARM 106														
161	LOWER ARM 107														
162	ELBOW 108														
163	WRIST 109														
164	HAND 110														
165	UPPER LEG 111														
166	LOWER LEG 112														
167	ANKLE 113														
168	FOOT 114														
169	SHOULDER 104														
170	THORAX 006														
171	ABDOMEN 007														
172	PELVIS 008														
173	GENITAL 009														
174	BACK 118														
175	BUTTOCKS 008														
176	INTERNAL ORGANS														
177	HEART 124														
178	LUNGS 125														
179	OTHER 116														
180	MULTI BODY PARTS/208														
181	TOTAL BODY 000														
182	SKULL 001														
183	FACE 002														
184	EYE 003														
185	NOSE 004														
186	NECK 005														
187	UPPER ARM 106														
188	LOWER ARM 107														
189	ELBOW 108														
190	WRIST 109														
191	HAND 110														
192	UPPER LEG 111														
193	LOWER LEG 112														
194	ANKLE 113														
195	FOOT 114														
196	SHOULDER 104														
197	THORAX 006														
198	ABDOMEN 007														
199	PELVIS 008														
200	GENITAL 009														
201	BACK 118														
202	BUTTOCKS 008														
203	INTERNAL ORGANS														
204	HEART 124														
205	LUNGS 125														
206	OTHER 116														
207	MULTI BODY PARTS/208														
208	TOTAL BODY 000														
209	SKULL 001														
210	FACE 002														
211	EYE 003														
212	NOSE 004														
213	NECK 005														
214	UPPER ARM 106														
215	LOWER ARM 107														
216	ELBOW 108														
217	WRIST 109														
218	HAND 110														
219	UPPER LEG 111														
220	LOWER LEG 112														
221	ANKLE 113														
222	FOOT 114														
223	SHOULDER 104														
224	THORAX 006														
225	ABDOMEN 007														
226	PELVIS 008														
227	GENITAL 009														
228	BACK 118														
229	BUTTOCKS 008														
230	INTERNAL ORGANS														
231	HEART 124														
232	LUNGS 125														
233	OTHER 116														
234	MULTI BODY PARTS/208														
235	TOTAL BODY 000														
236	SKULL 001														
237	FACE 002														
238	EYE 003														
239	NOSE 004														
240	NECK 005														
241	UPPER ARM 106														
242	LOWER ARM 107														
243	ELBOW 108														
244	WRIST 109														
245	HAND 110														
246	UPPER LEG 111														
247	LOWER LEG 112														
248	ANKLE 113														
249	FOOT 114														
250	SHOULDER 104														
251	THORAX 006														
252	ABDOMEN 007														
253	PELVIS 008														
254															

TOTAL EJECTEES: 67
FATALITIES: 11
RECOVERED: 9 LOST:

INJURY DIAGNOSIS	INJURY DIAGNOSIS		INJURY DIAGNOSIS	
	BODY PART INJURED	BODY PART INJURED		
HEAD/NECK	SKULL (01)	TRANSECTION (17)	VERTEBRAL	
	FACE (02)	CODE NOT IN SAFECEN	C1	
	EYE (03)	MULTIPLE EXTREME (98)	16	
	NOSE (22)	POISONING SYSTEMIC (95)	18	
	NECK (04)	UNKNOWN/OTHER (99)	19	
	ARMS	UPPER ARM (14)	DROWNING (95)	C2
		LOWER ARM (15)	ABRASION (01)	C3
		ELBOW (21)	HEMORRHAGE (29)	C4
		WRIST (18)	HEMATOMA (28)	C5
		HAND (17)	EDEMA (48)	C6
LEGS	UPPER LEG (10)	ACUSTIC TRAUMA (92)	C7	
	LOWER LEG (11)	BITE (05)	11	
	KNEE (21)	SCRATCH (34)	12	
	ANKLE (12)	PERFORATION (33)	13	
	FOOT (13)	LACERATION (30)	14	
TRUNK	SKULL DLR (05)	FOREIGN BODY IN ORIFICE (20)	15	
	THORAX (06)	THERMAL BURN (52)	16	
	ABDOMEN (07)	INFARCT (50)	17	
	PELVIS (08)	EMBOLISM (29)	18	
	GIROIN (23)	HEMORRHAGE (29)	19	
INTERNAL ORGANS	BACK (19)	RIPTURE (33)	1	
	BUTTOCKS (09)	INTERNAL INJURY (64)	1	
	HEART (24)	SHOCK (60)	1	
	LUNGS (25)	TRAUMATIC THORAX (28)	1	
	OTHER (19)	NON FATAL (24)	1	
MULTI BODY PARTS (26)	SUBMERSSION (171)	1		
TOTAL BODY (04)	COLD INJURY (141)	UNCONSCIOUSNESS (13)	1	
	AMPUTATION	CONCUSSION (135)	SPRAIN (136)	1
		TEAR MUSCLE (46)	STRAIN (136)	1
		DISLOCATION (145)	LIGAMENT (140)	1
		DEANGEMENT (145)	TEAR MUSCLE (46)	1
		CRUSHING (145)	DISLOCATION (145)	1
	TRANSECTION	SKIN FRACTURE (126)	COMPRESSION FRACTURE (121)	1
		COMMINUTED FRACTURE (110)	COMMINUTED FRACTURE (111)	1
		COMMINUTED FRACTURE (109)	COMMINUTED FRACTURE (110)	1
		EXSANGUINATION (147)	TRANSECTION (119)	1
DECAPITATION (161)		AVIATION (161)	1	
UNKNOWN/OTHER	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	
	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	UNKNOWN/OTHER (99)	

(CODES: 1 & 5)

JAN 1969 - DEC 1979

TOTAL EJECTEES: 348

SURVIVORS: 708

INJURED SURVIVORS: 107

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TOTAL EJECTEES: 7
SURVIVORS: 7
INJURED SURVIVORS: 0

[illegible]

JANUARY 1969 - DECEMBER 1979

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JANUARY 1969 - DECEMBER 1979

FATALITIES 11

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-54-

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-55-

JANUARY 1969 - DECEMBER 1979

[illegible]

JANUARY 1969 - DECEMBER 1979

-57-

JANUARY 1969 - DECEMBER 1979

CATALYTICS OVER WATER 9

-58-

JANUARY 1969 - DECEMBER 1979

[illegible]

JANUARY 1969 - DECEMBER 1979

[illegible]

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-61-

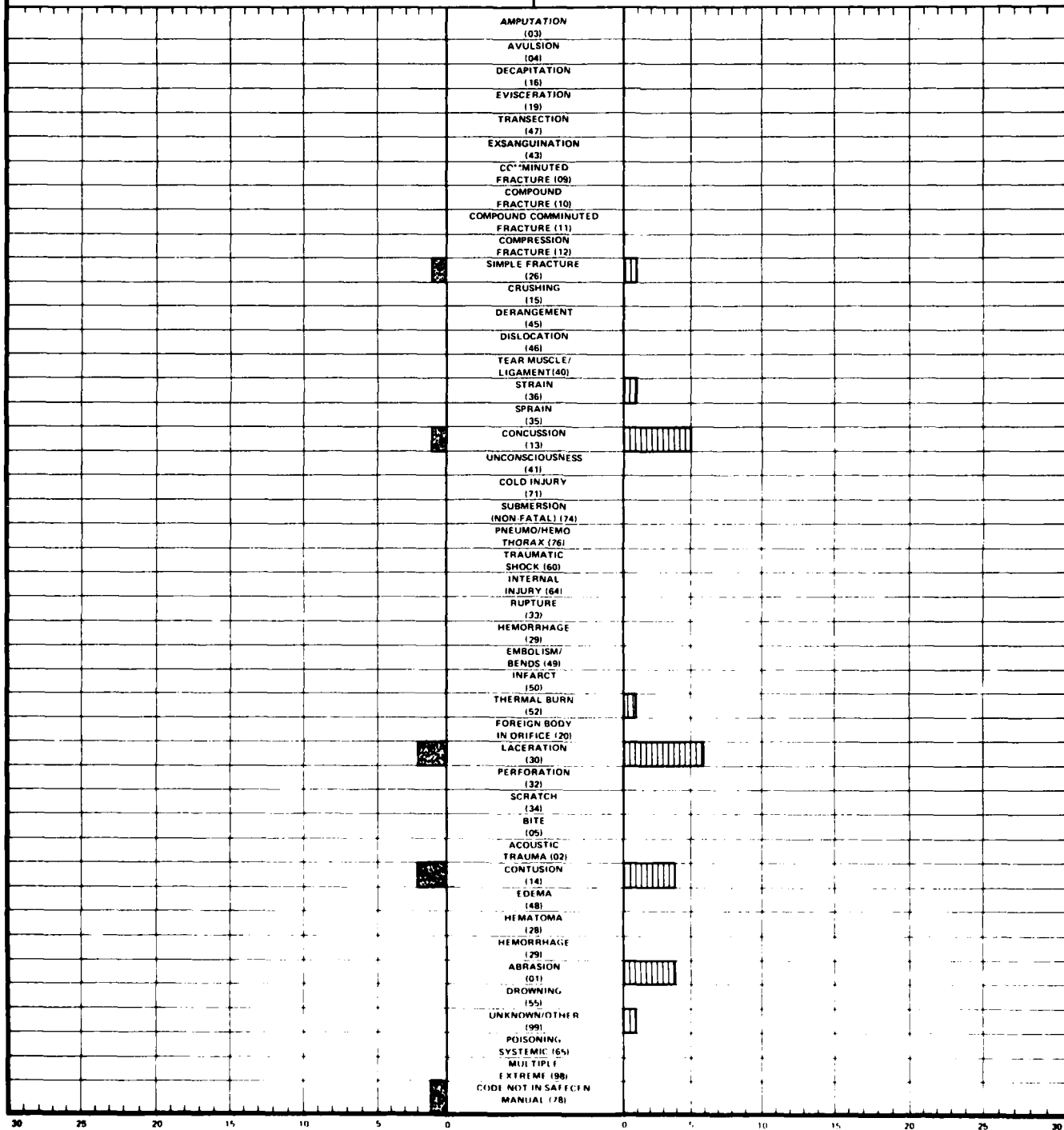
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

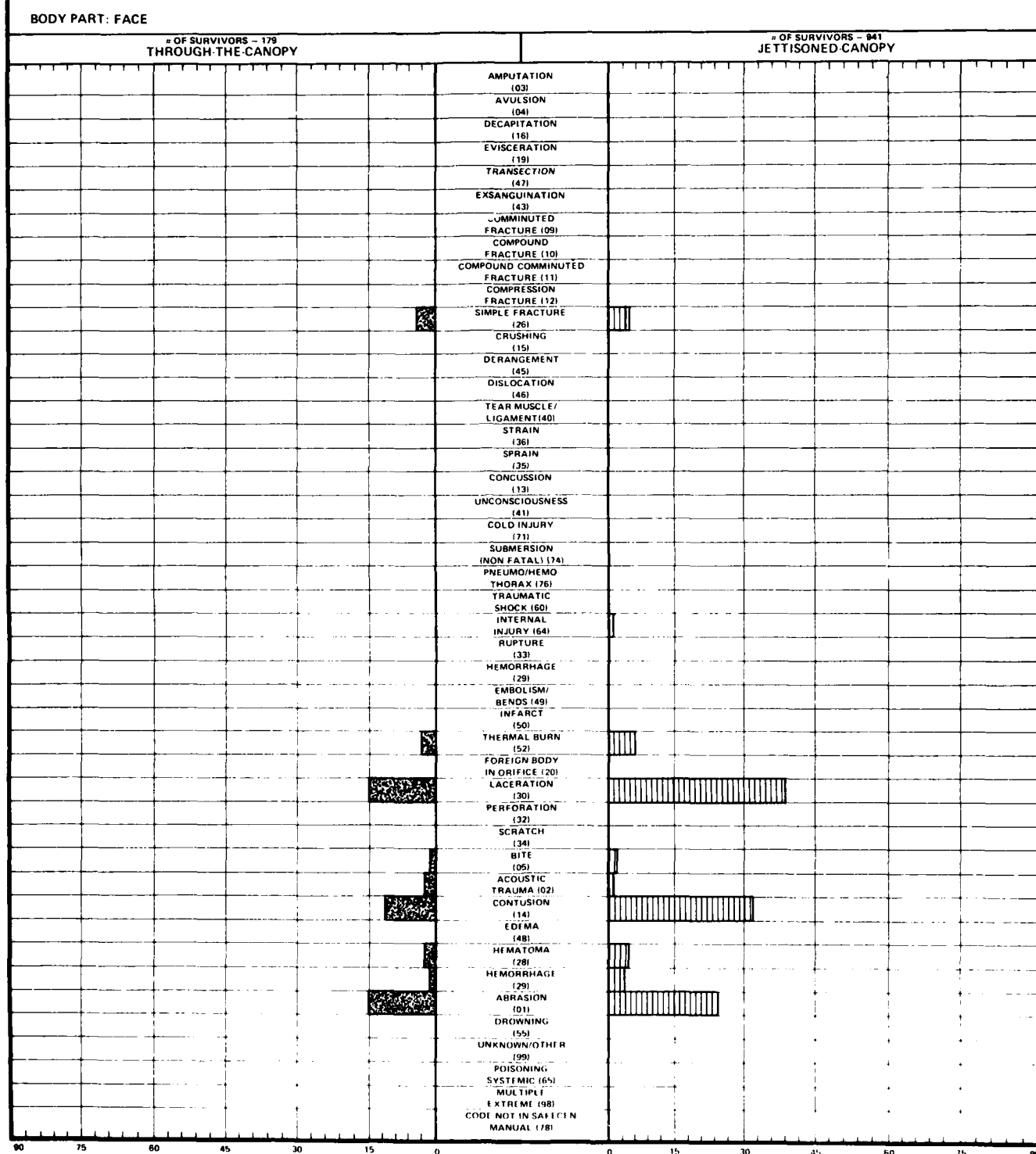
BODY PART: SKULL

OF SURVIVORS - 178
THROUGH-THE-CANOPY

OF SURVIVORS - 841
JETTISONED-CANOPY



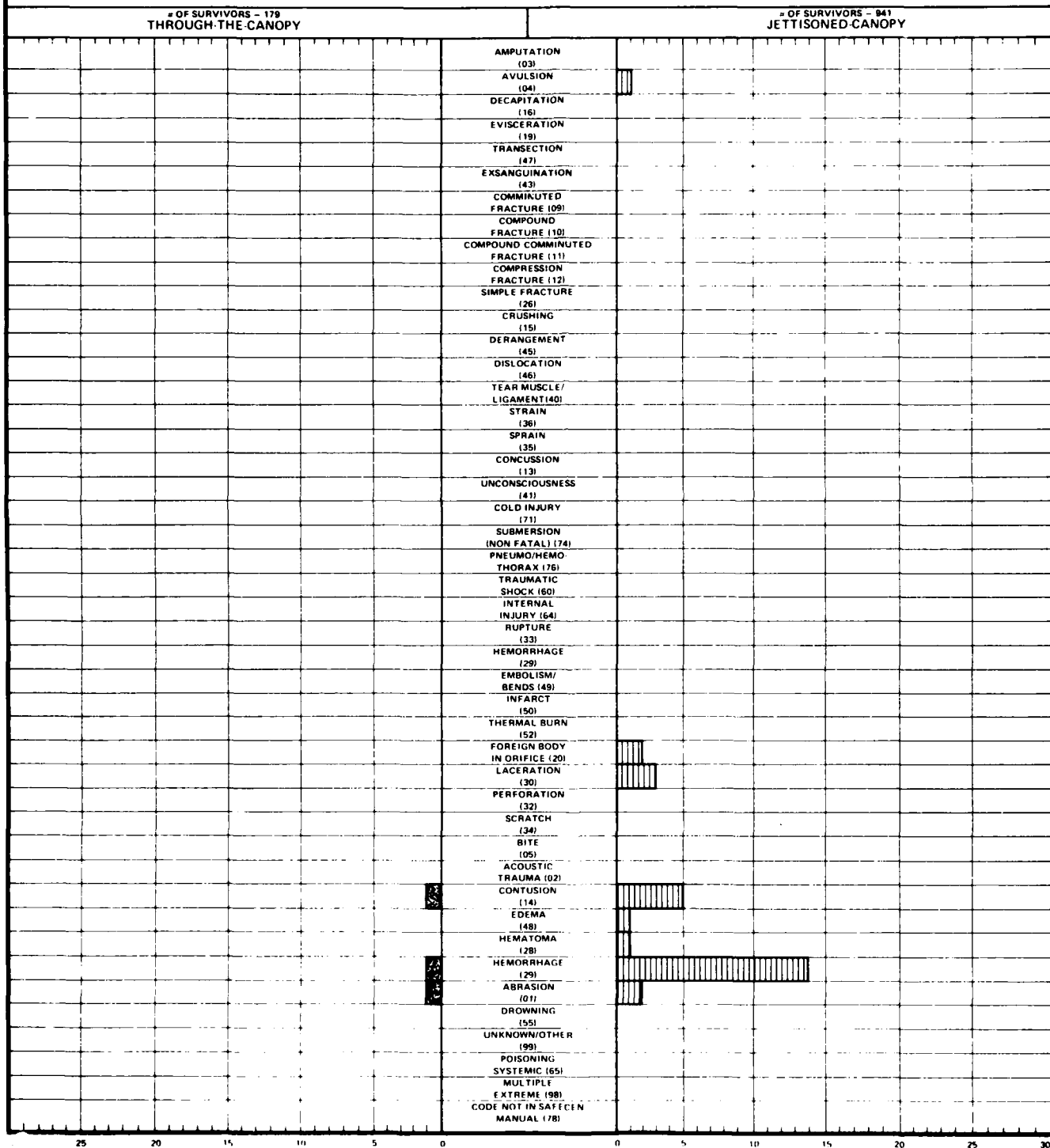
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: EYE

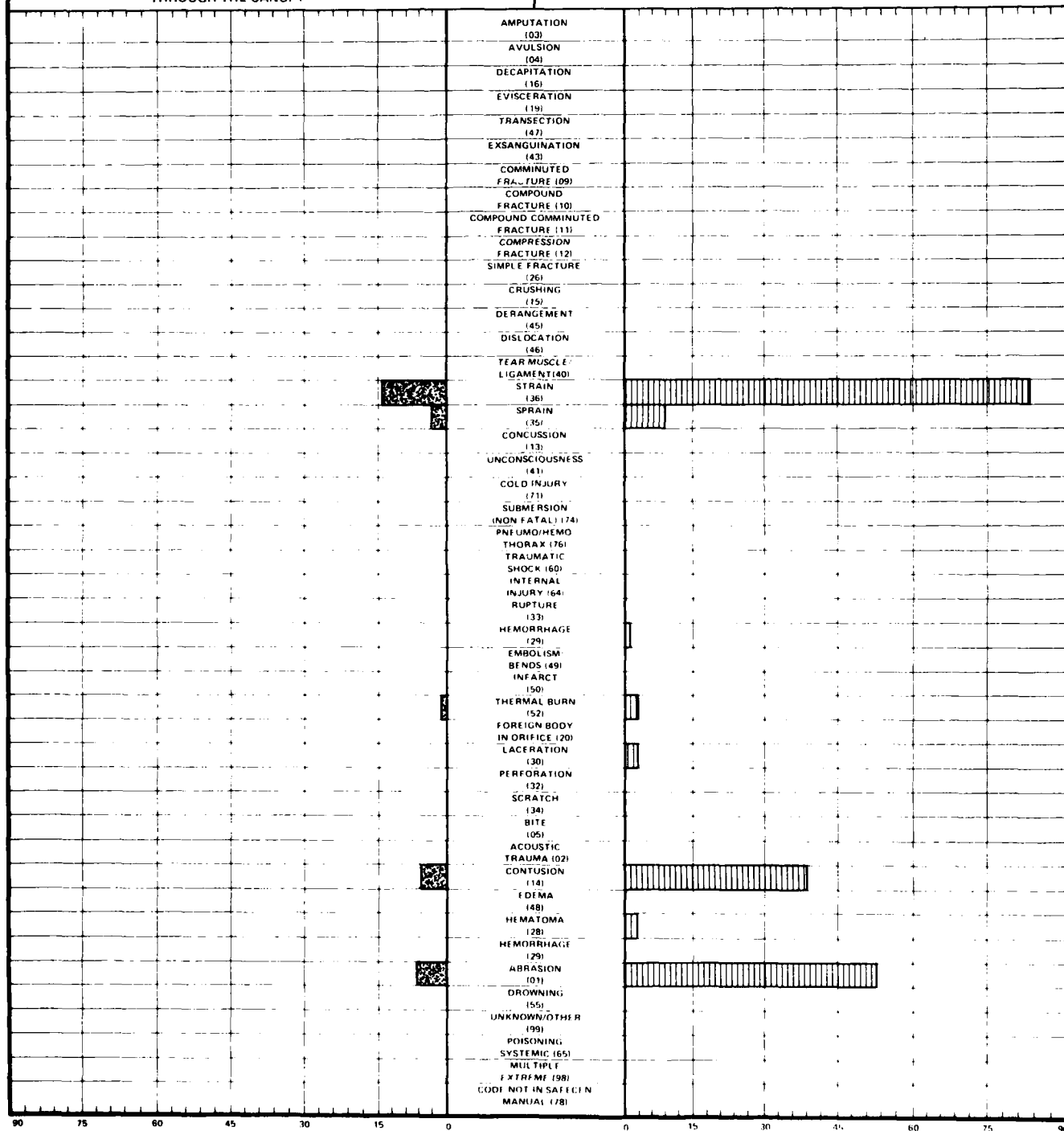


COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: NECK

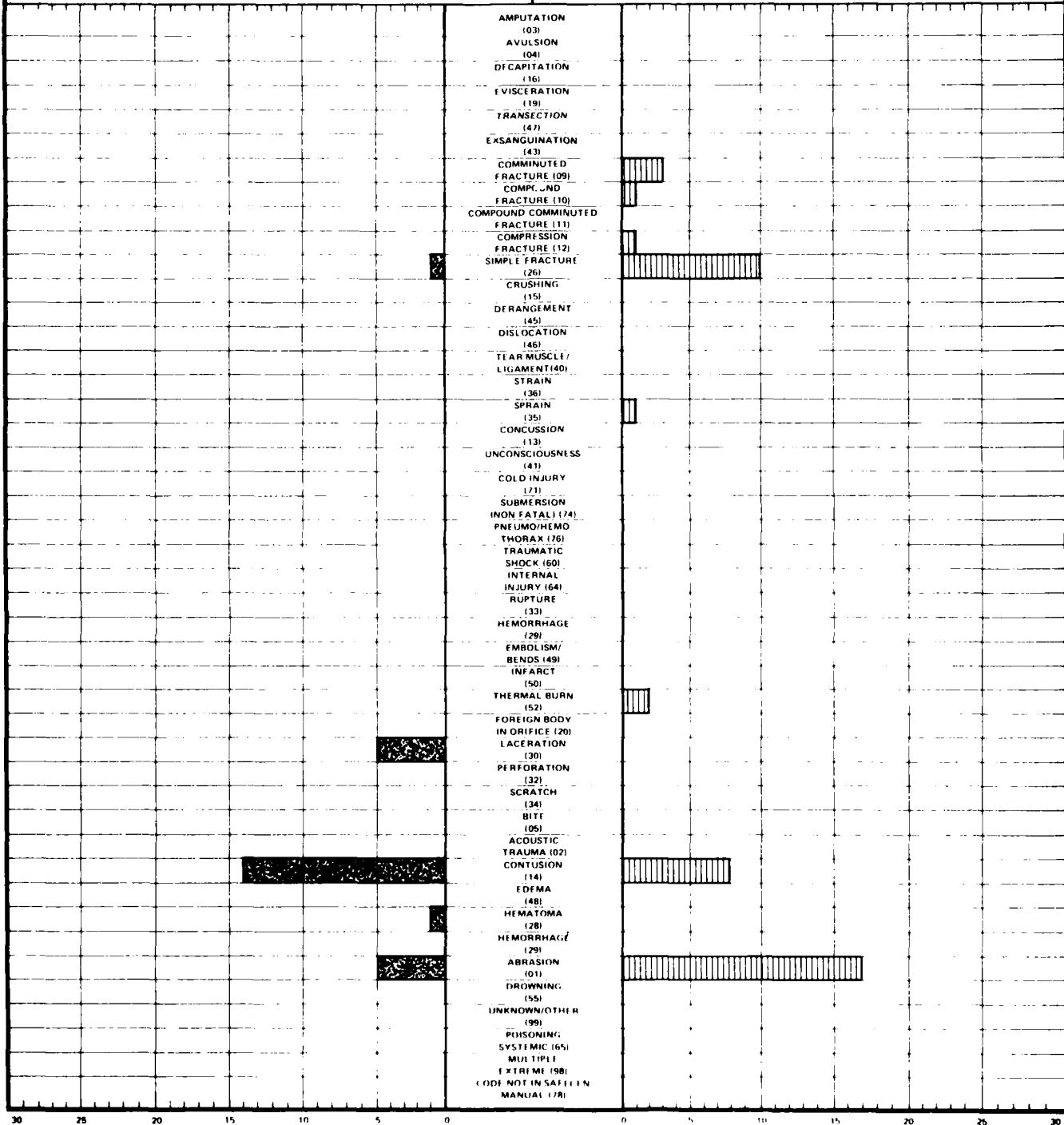
OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



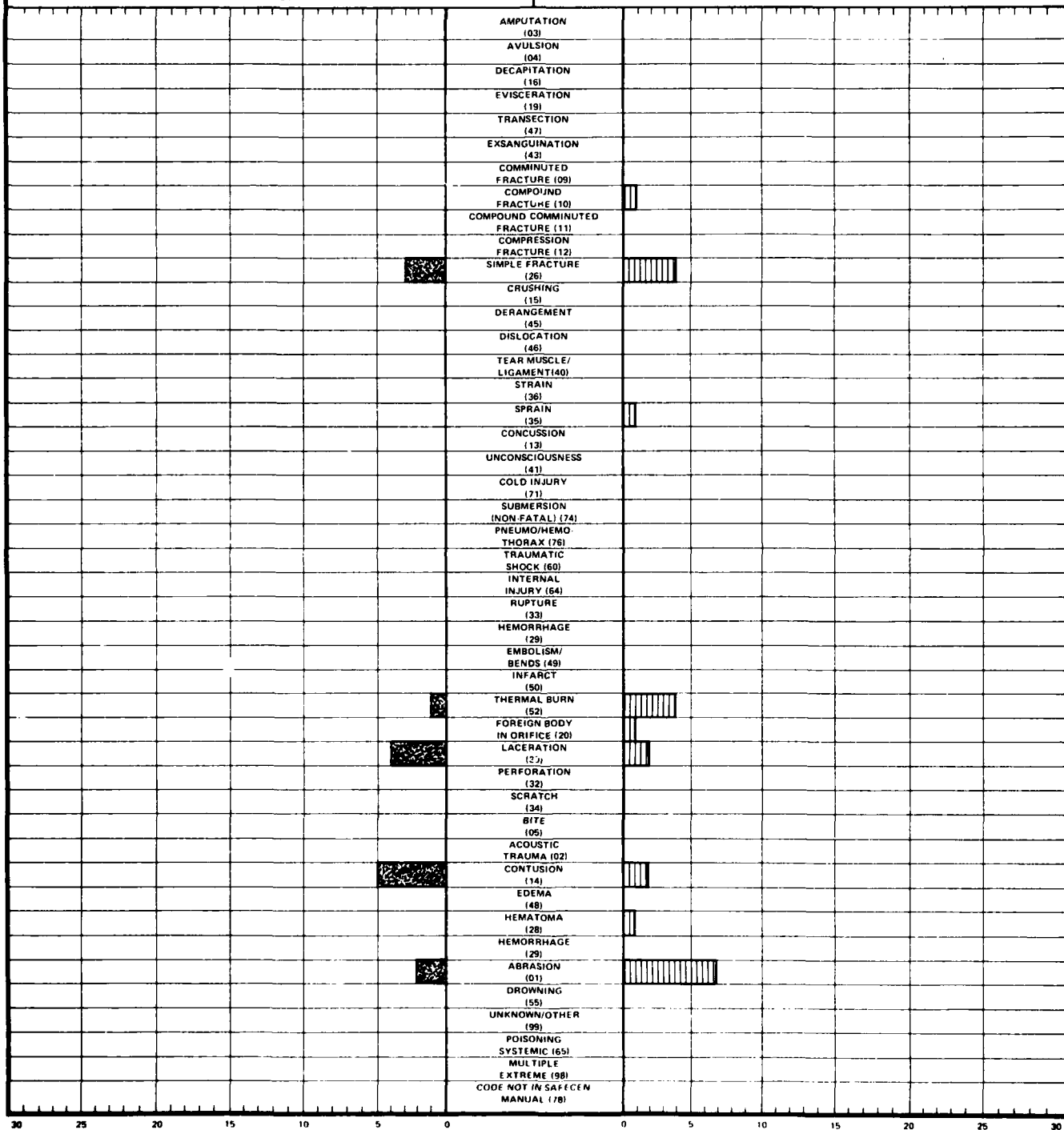
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH THE CANOPY VS. JETTISONED CANOPY EJECTIONS

BODY PART: UPPER ARM

OF SURVIVORS - 179
THROUGH THE CANOPY# OF SURVIVORS - 941
JETTISONED-CANOPY

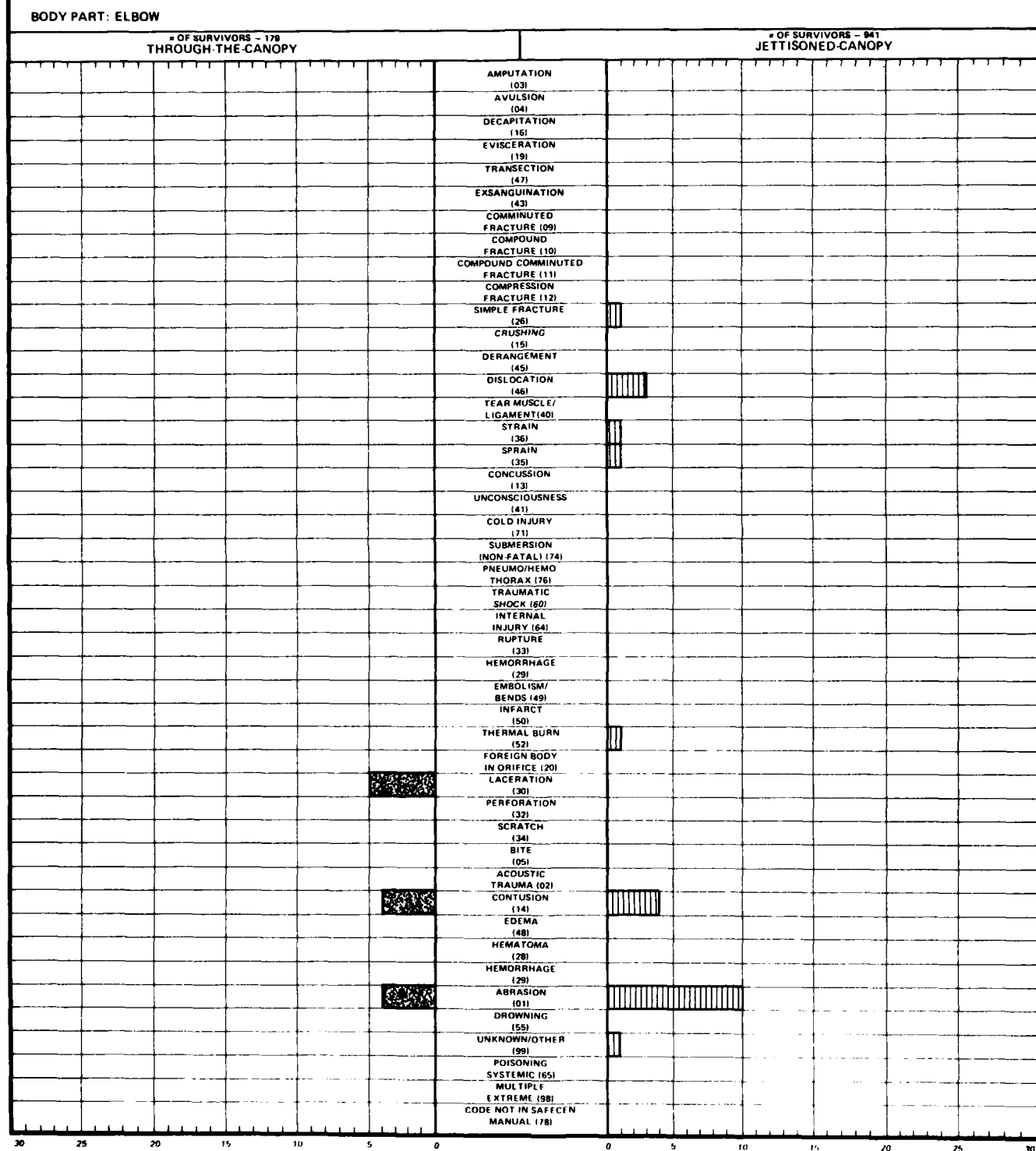
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: LOWER ARM

OF SURVIVORS - 179
THROUGH-THE-CANOPY# OF SURVIVORS - 941
JETTISONED-CANOPY

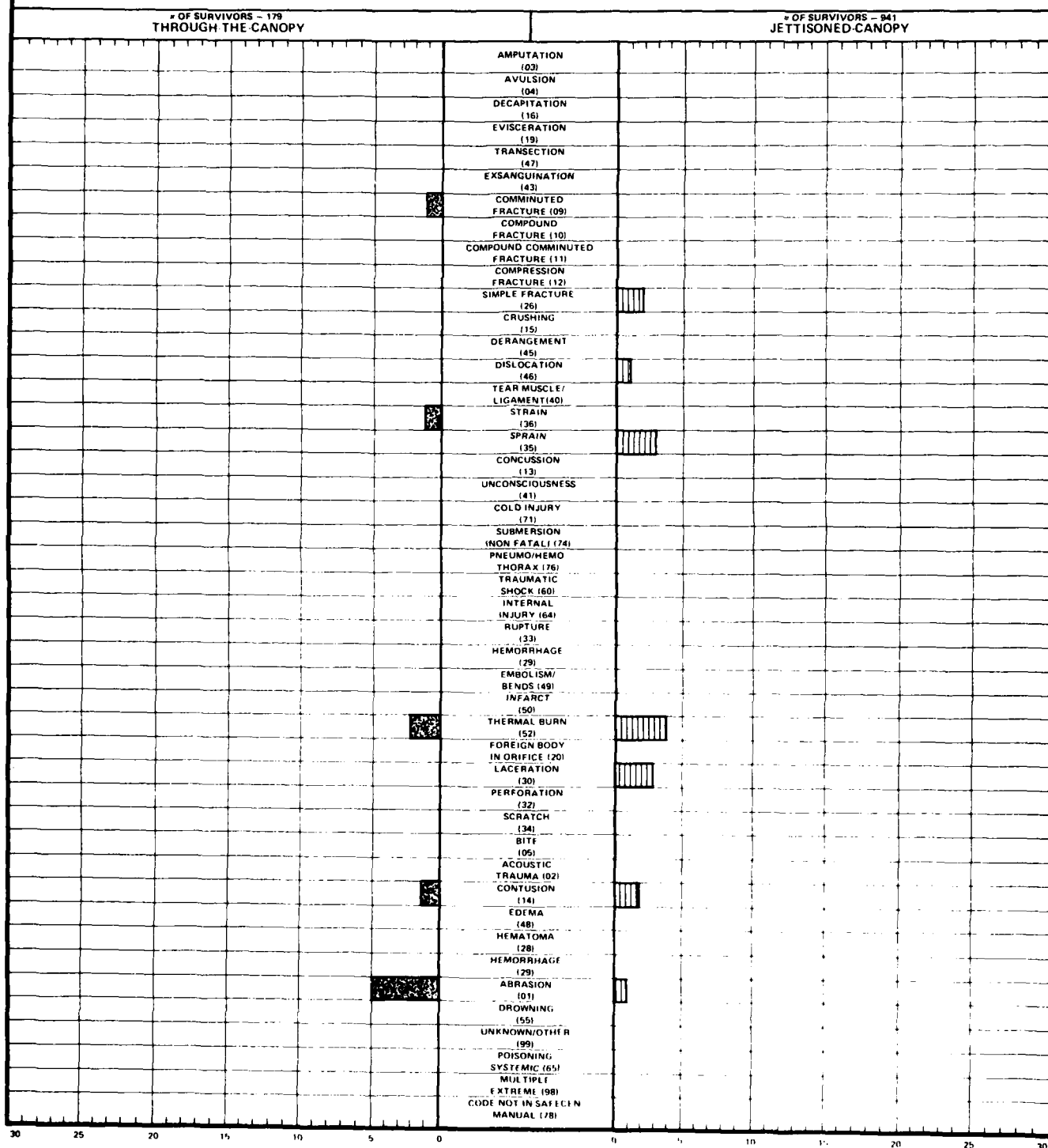
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)



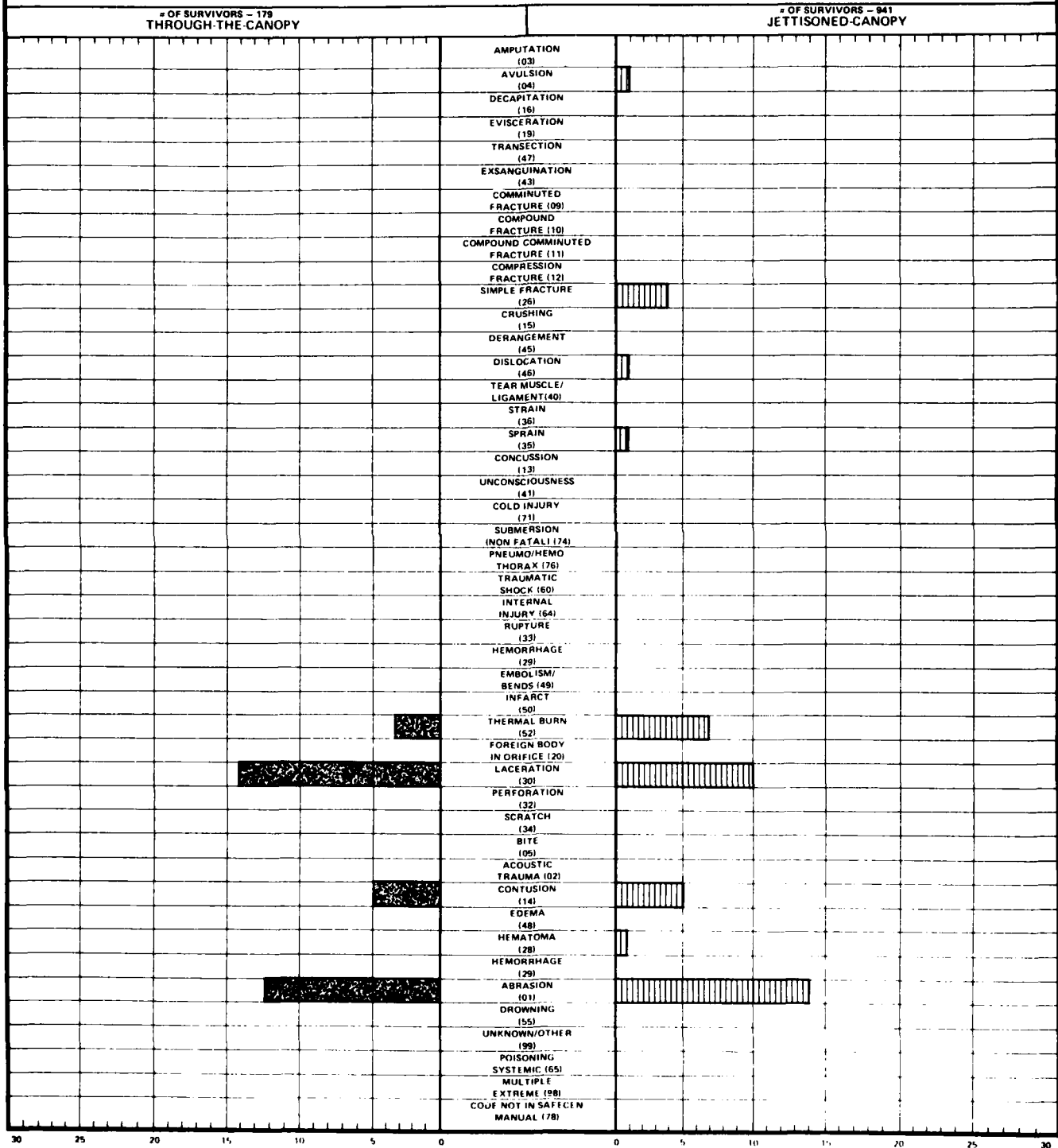
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: WRIST



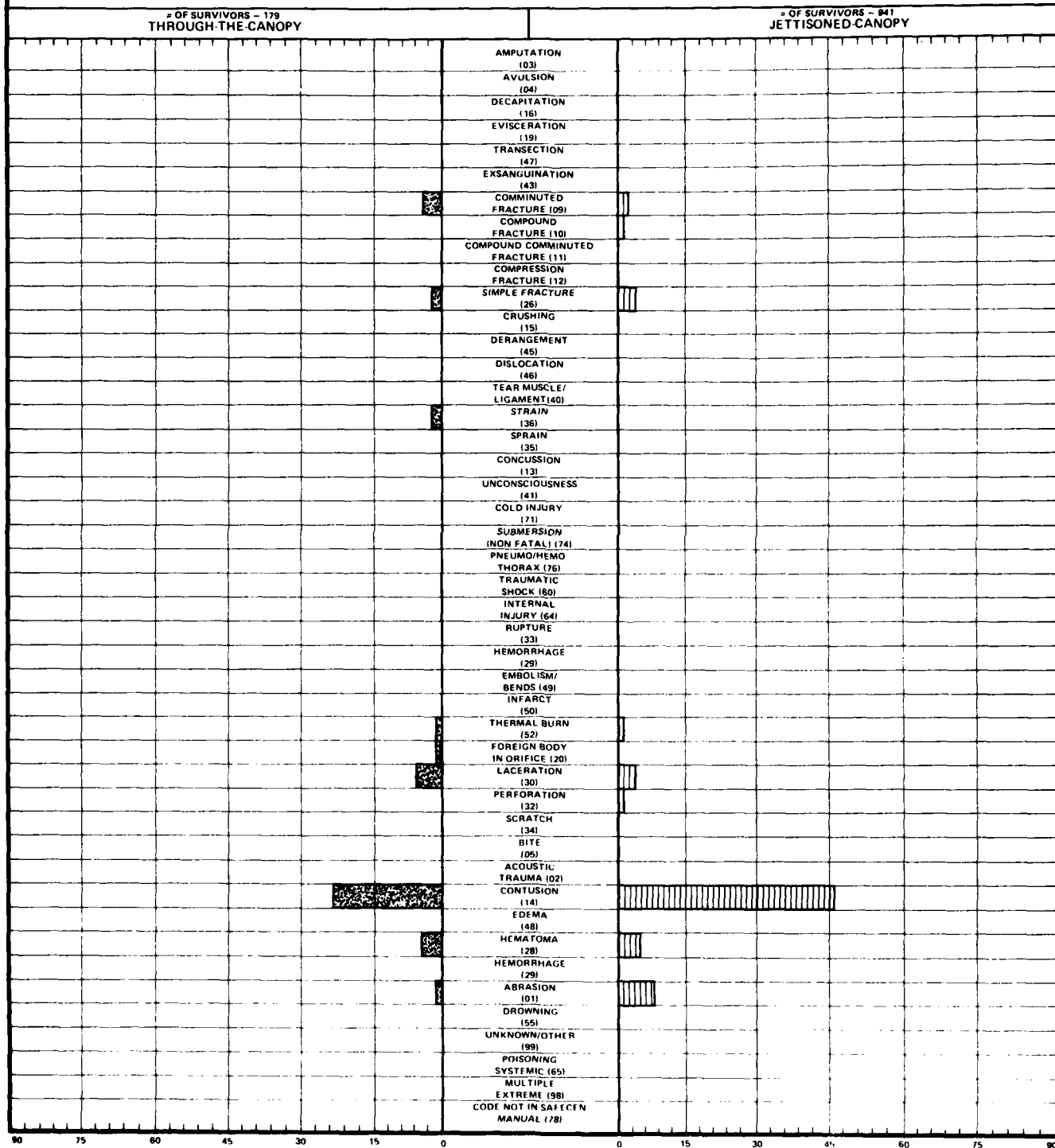
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: HAND



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

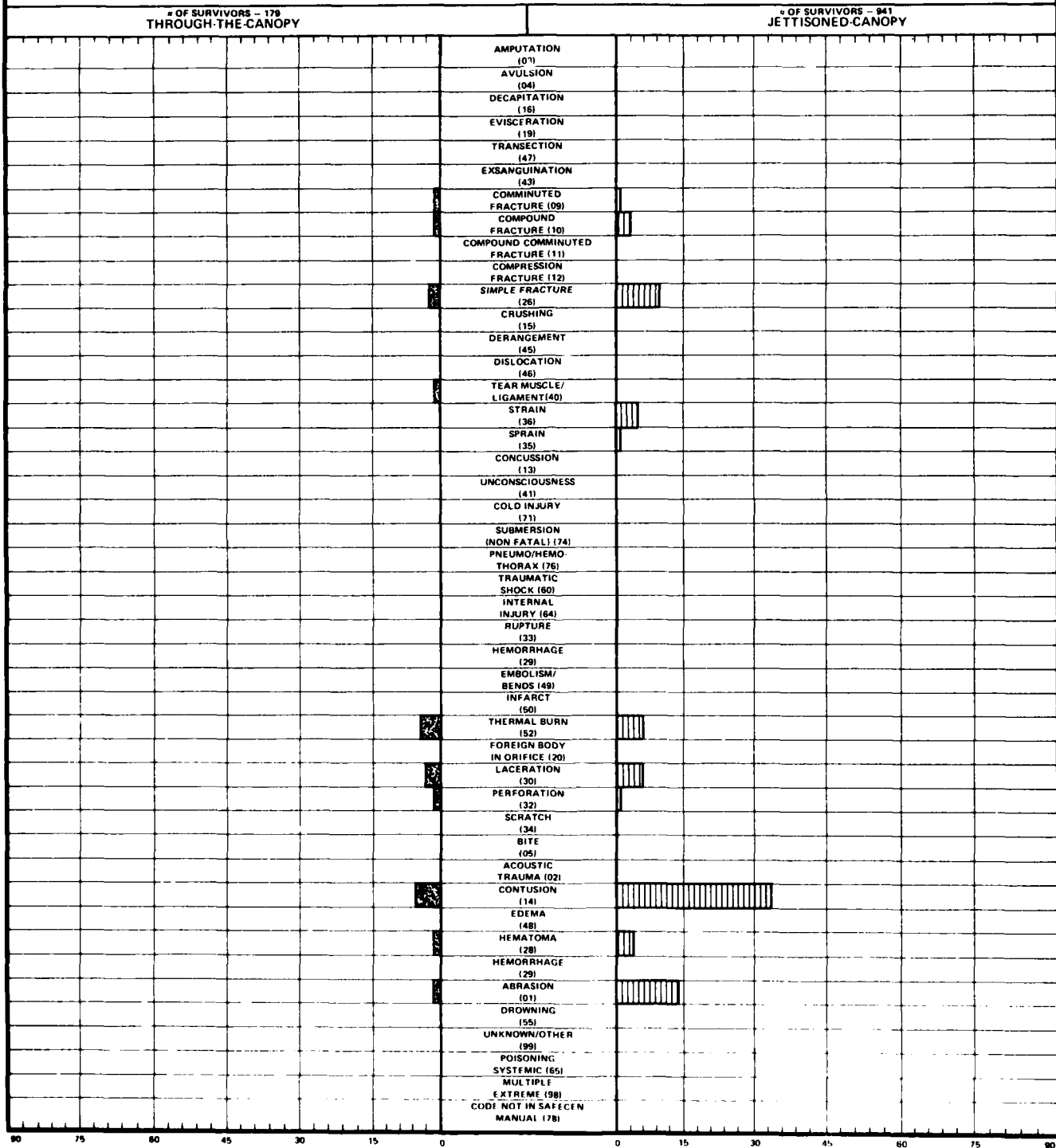
BODY PART: UPPER LEG



JANUARY 1969 - DECEMBER 1979

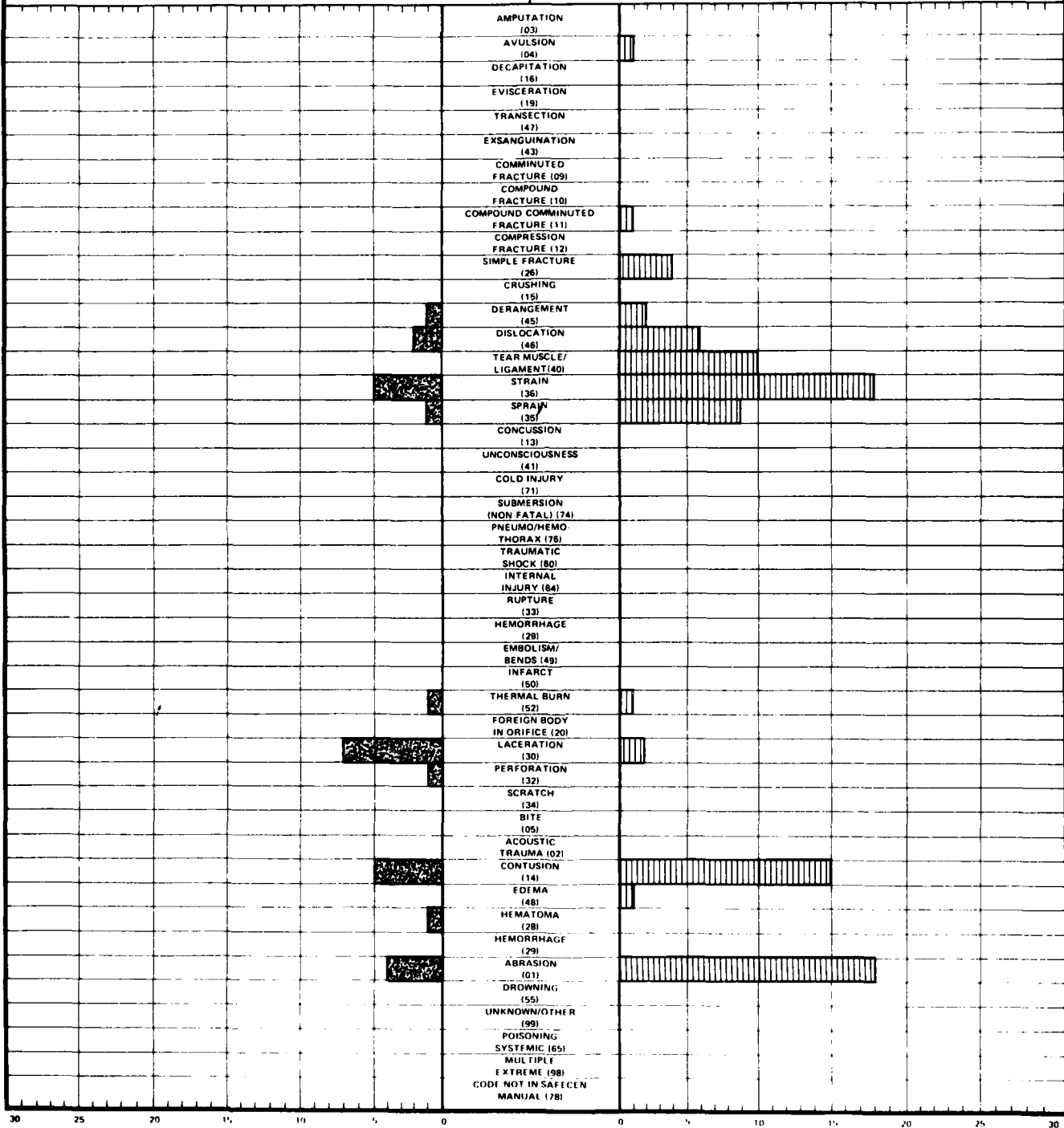
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: LOWER LEG



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: KNEE

OF SURVIVORS - 179
THROUGH-THE-CANOPY# OF SURVIVORS - 841
JETTISONED-CANOPY

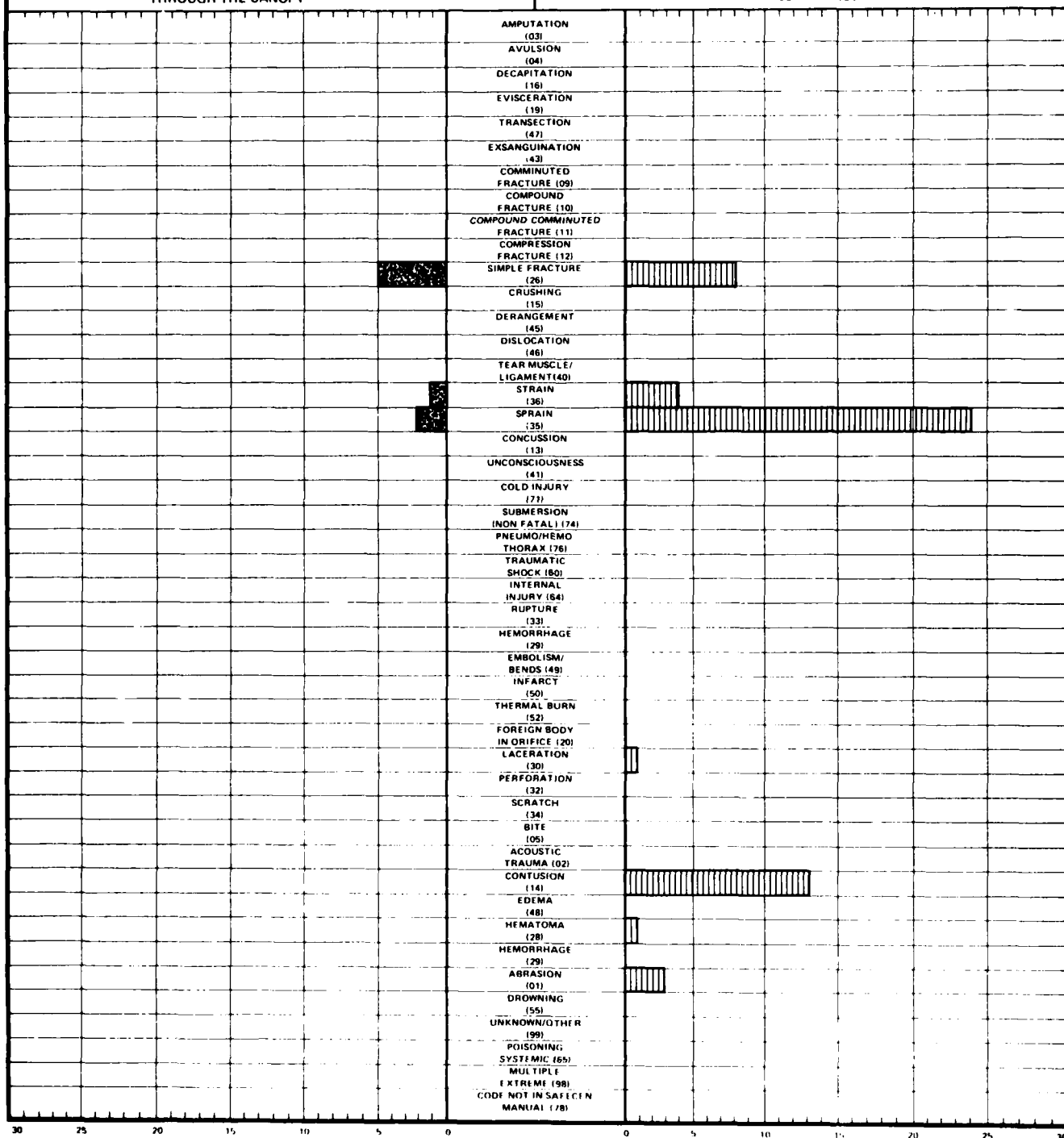
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: ANKLE

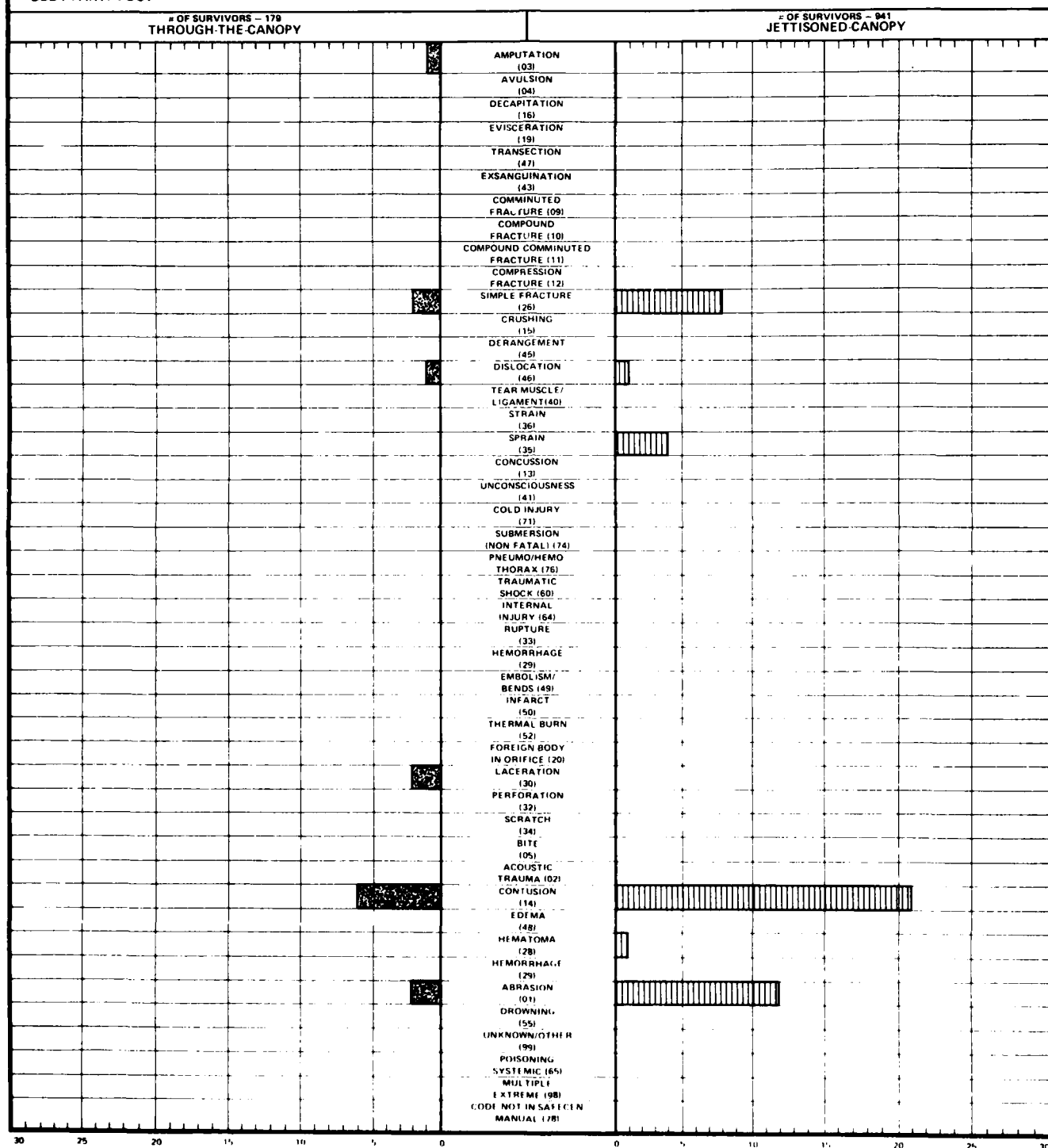
OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



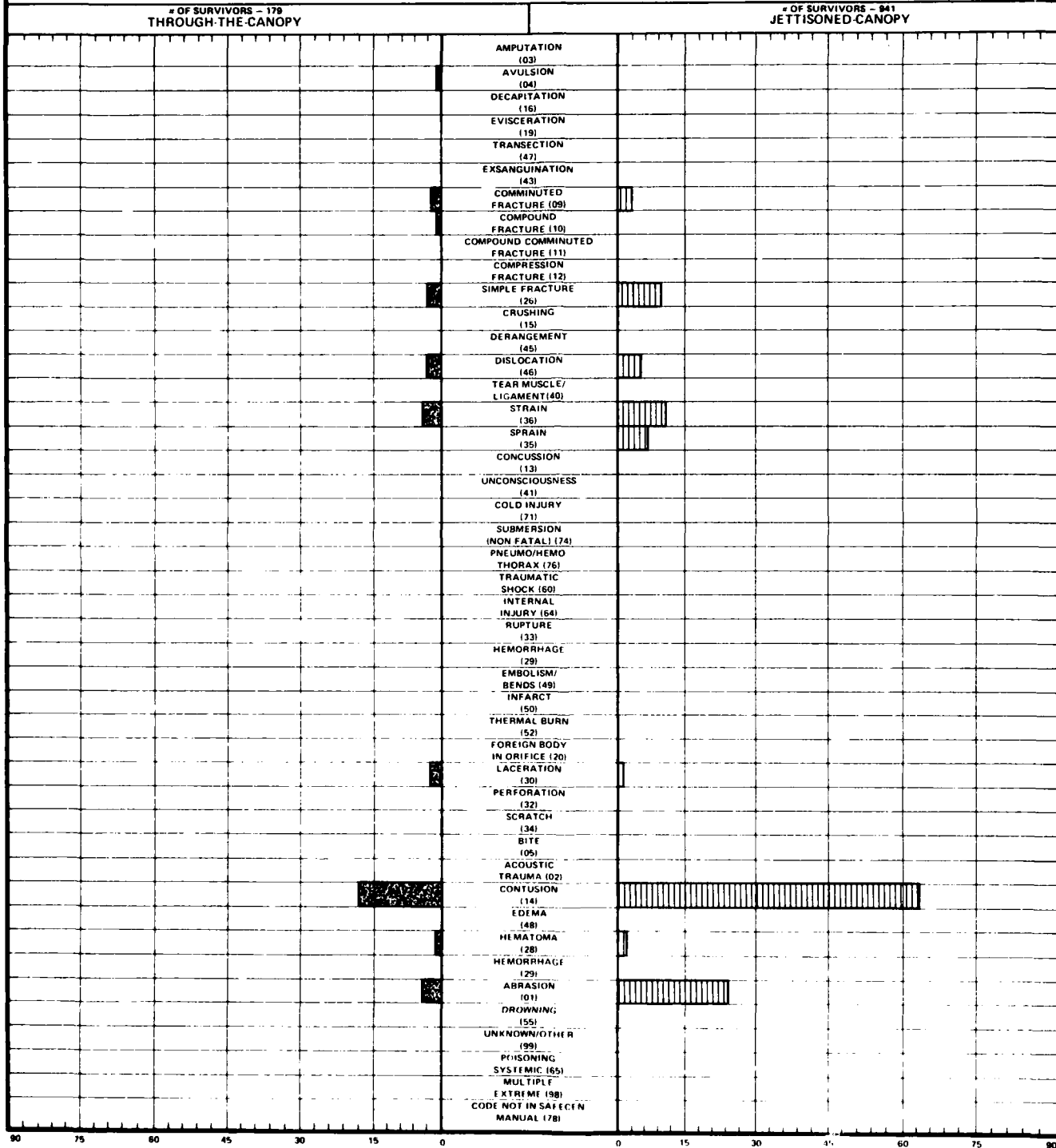
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: FOOT



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

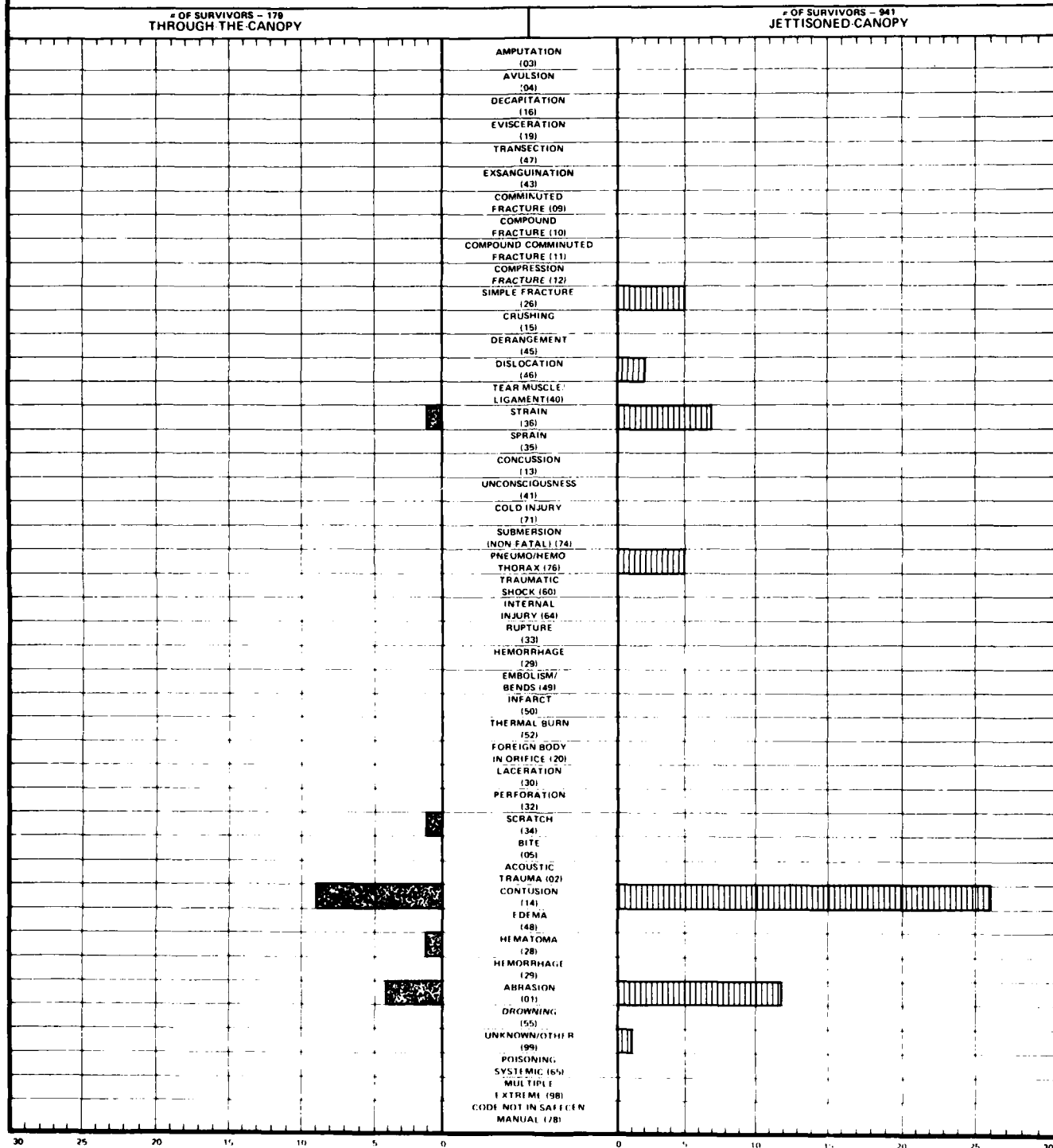
BODY PART: SHOULDER



JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: THORAX



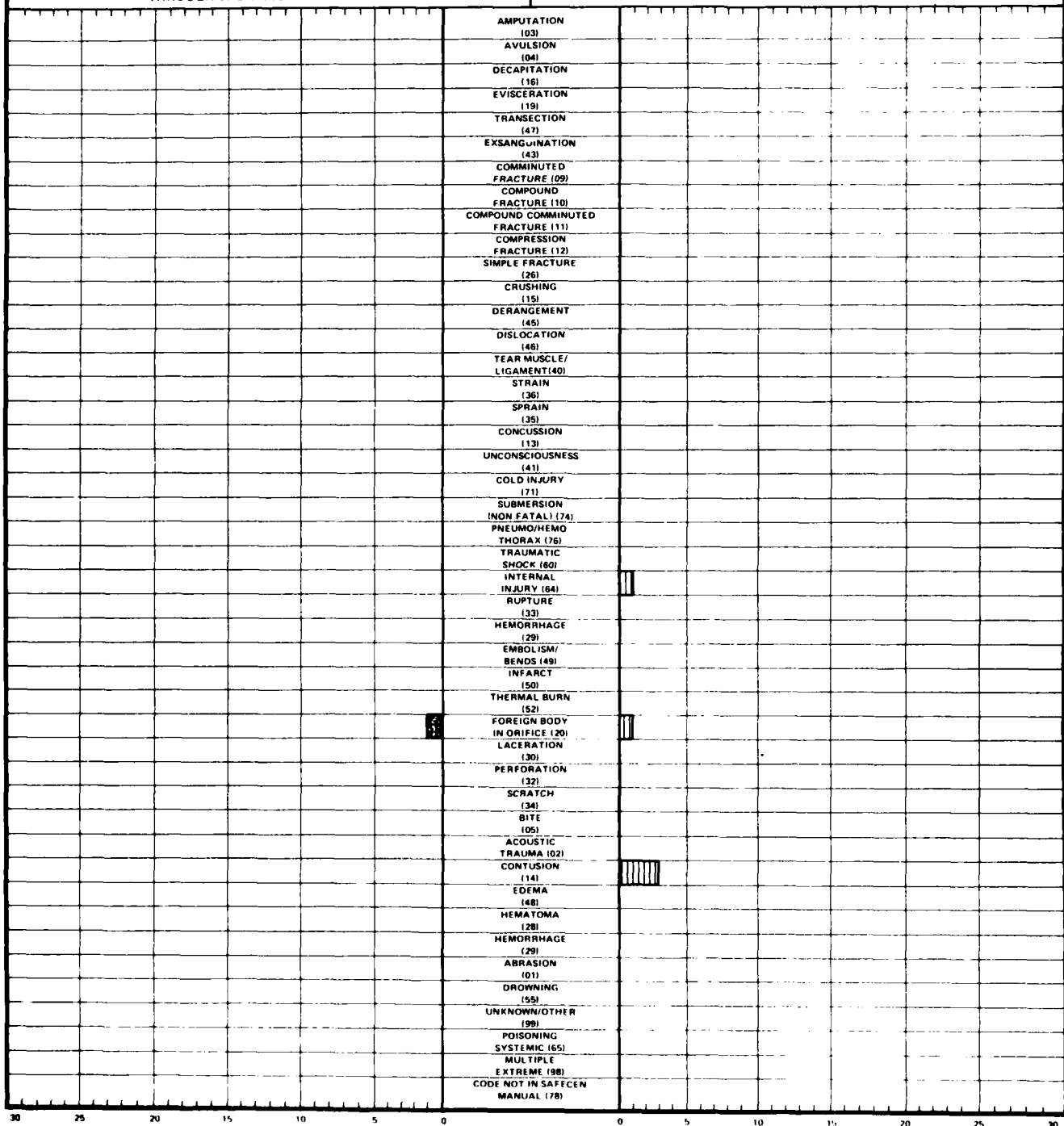
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: ABDOMEN

OF SURVIVORS - 178
THROUGH-THE-CANOPY

OF SURVIVORS - 841
JETTISONED CANOPY



JANUARY 1969 - DECEMBER 1979

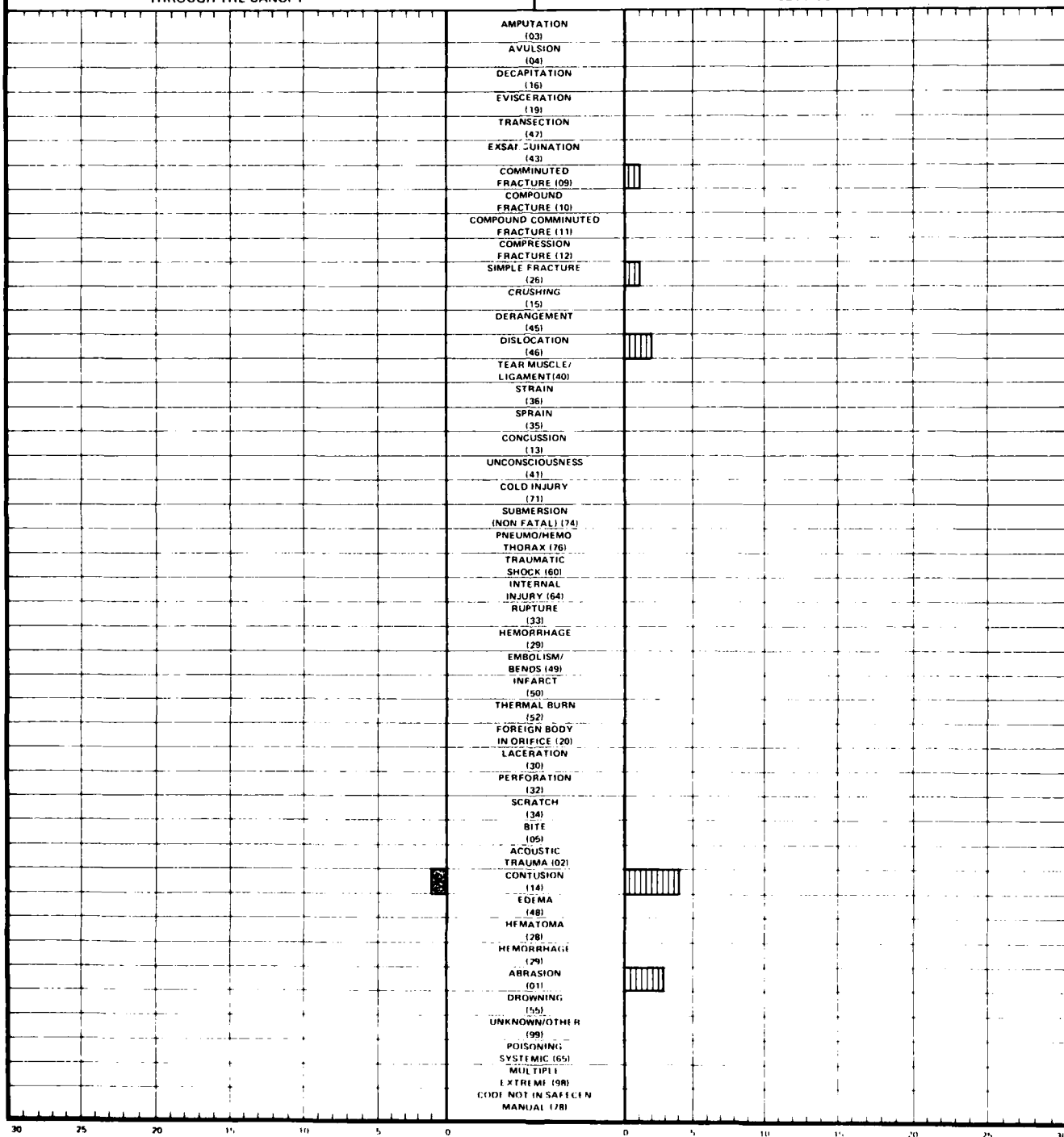
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

BODY PART: PELVIS

OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



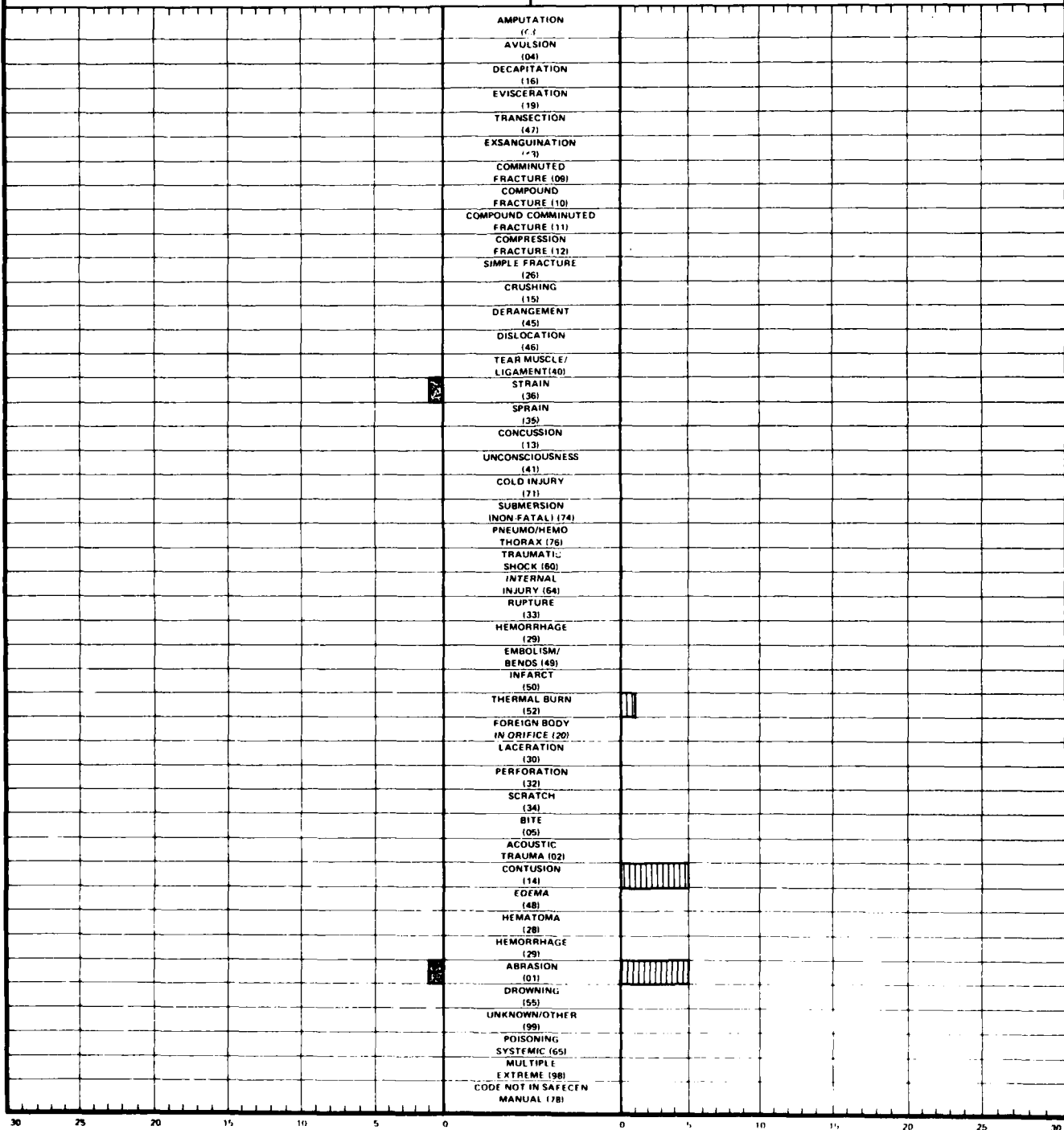
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH THE CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: GROIN

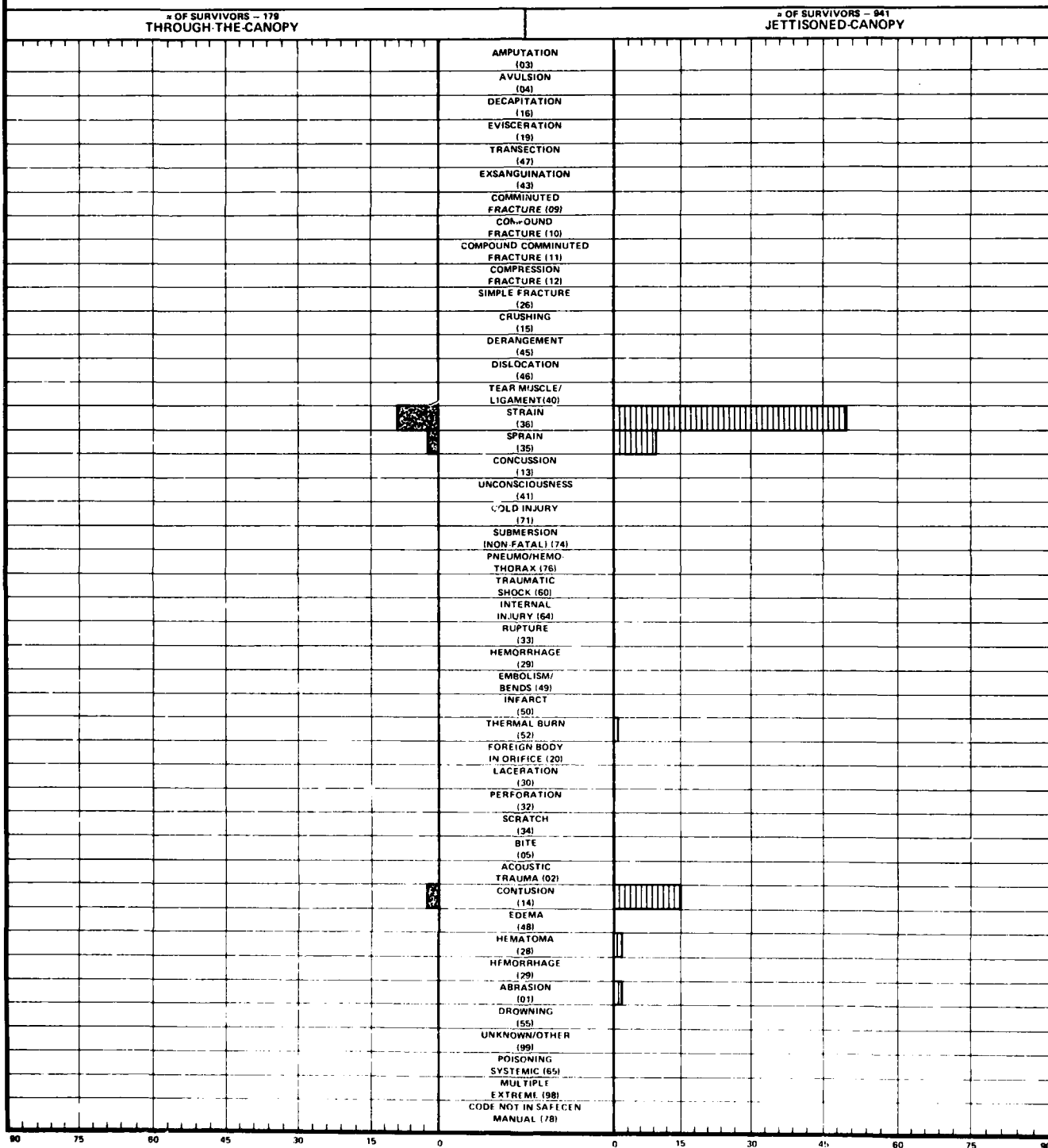
OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



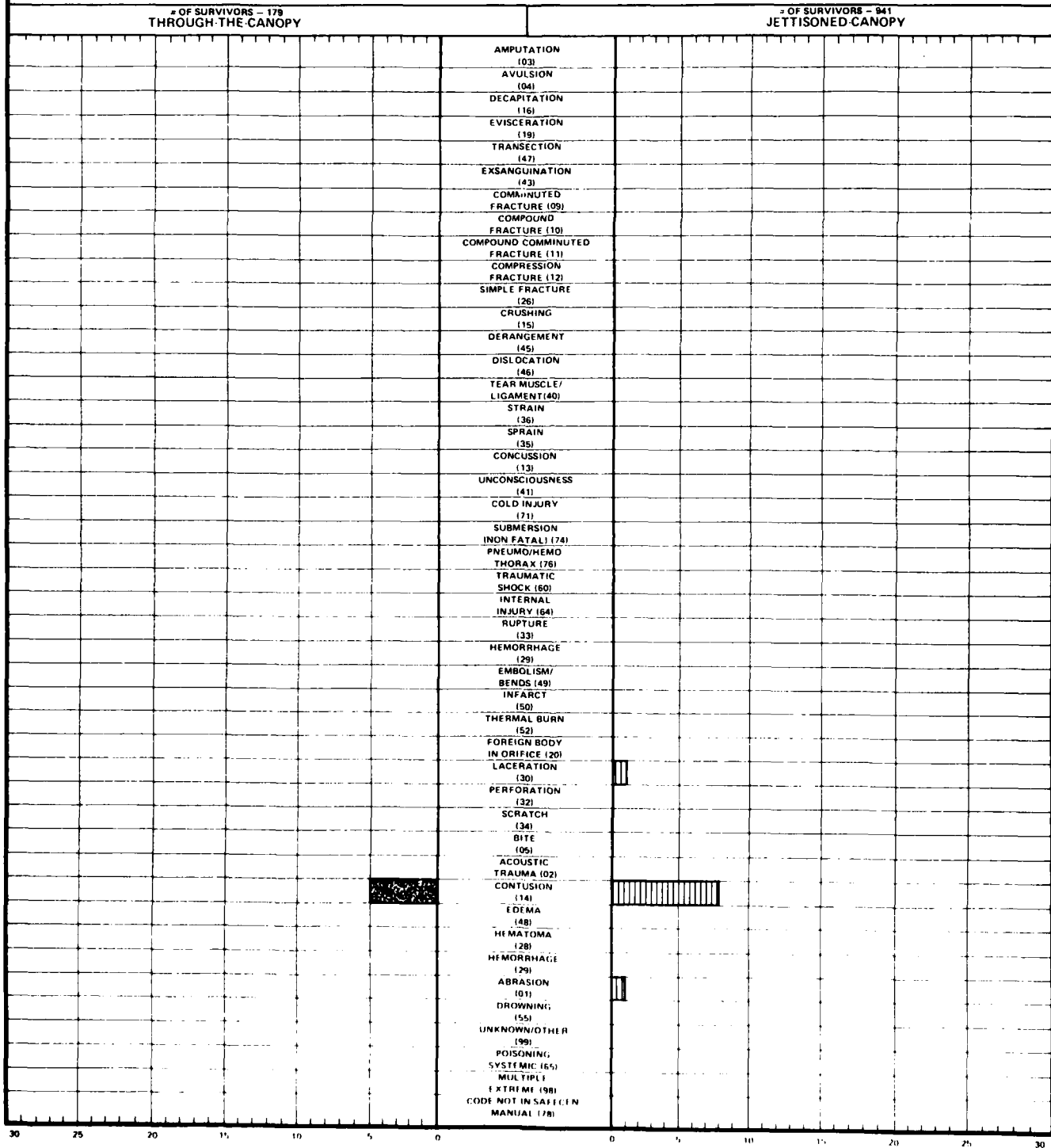
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: BACK



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: BUTTOCKS



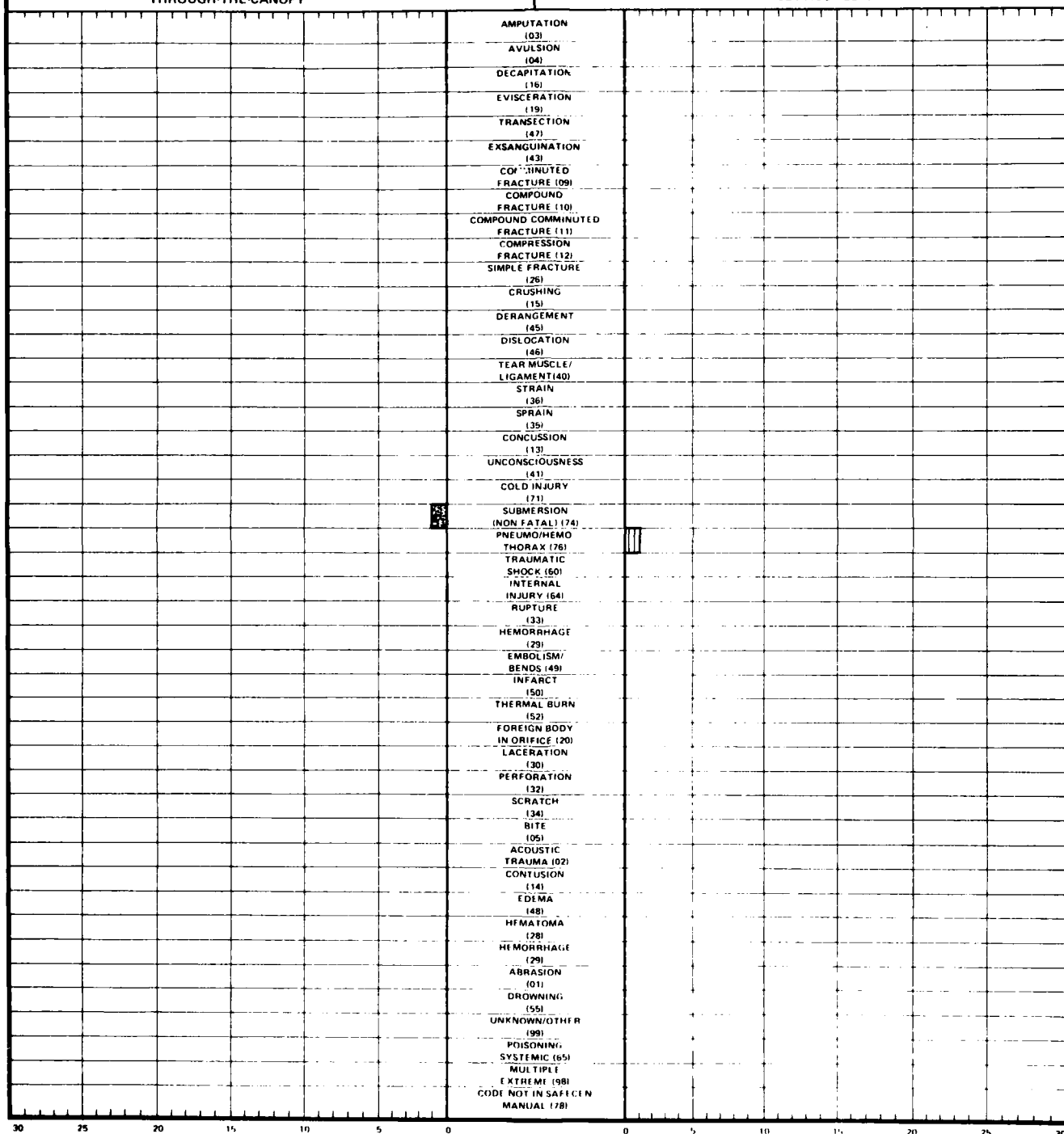
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: LUNGS

OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



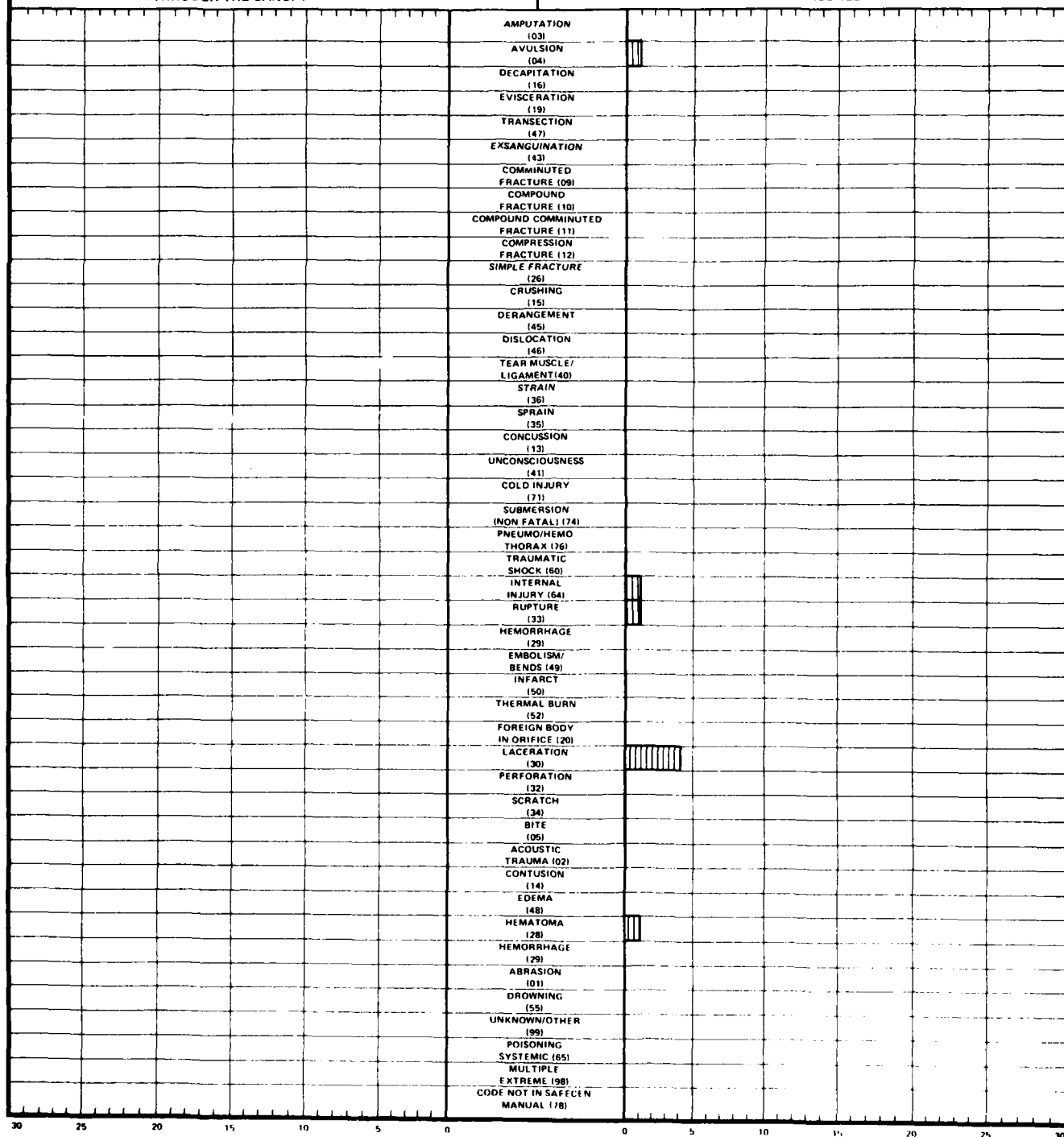
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: OTHER

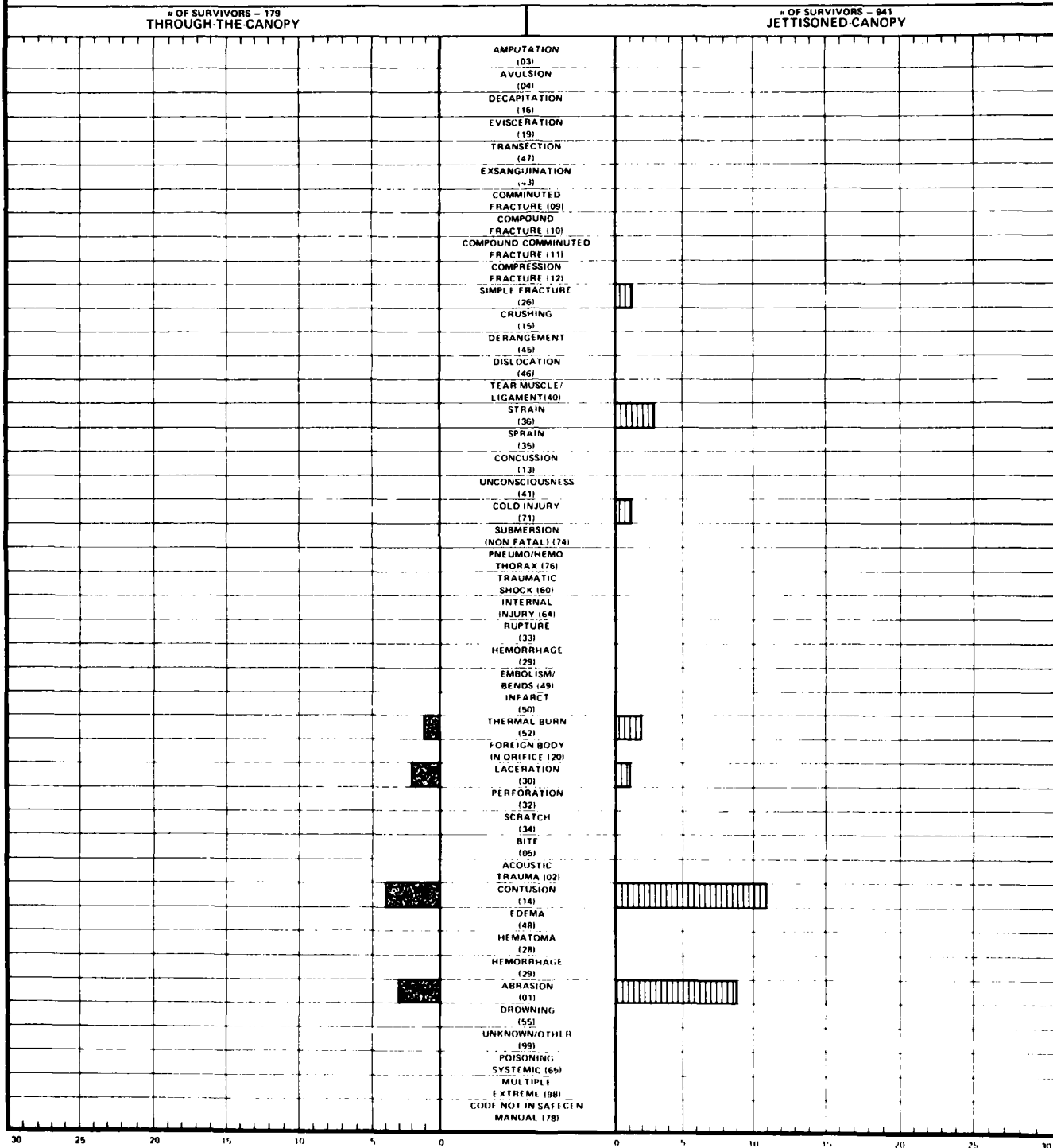
OF SURVIVORS - 179
THROUGH-THE-CANOPY

OF SURVIVORS - 941
JETTISONED-CANOPY



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: MULT. BODY PARTS



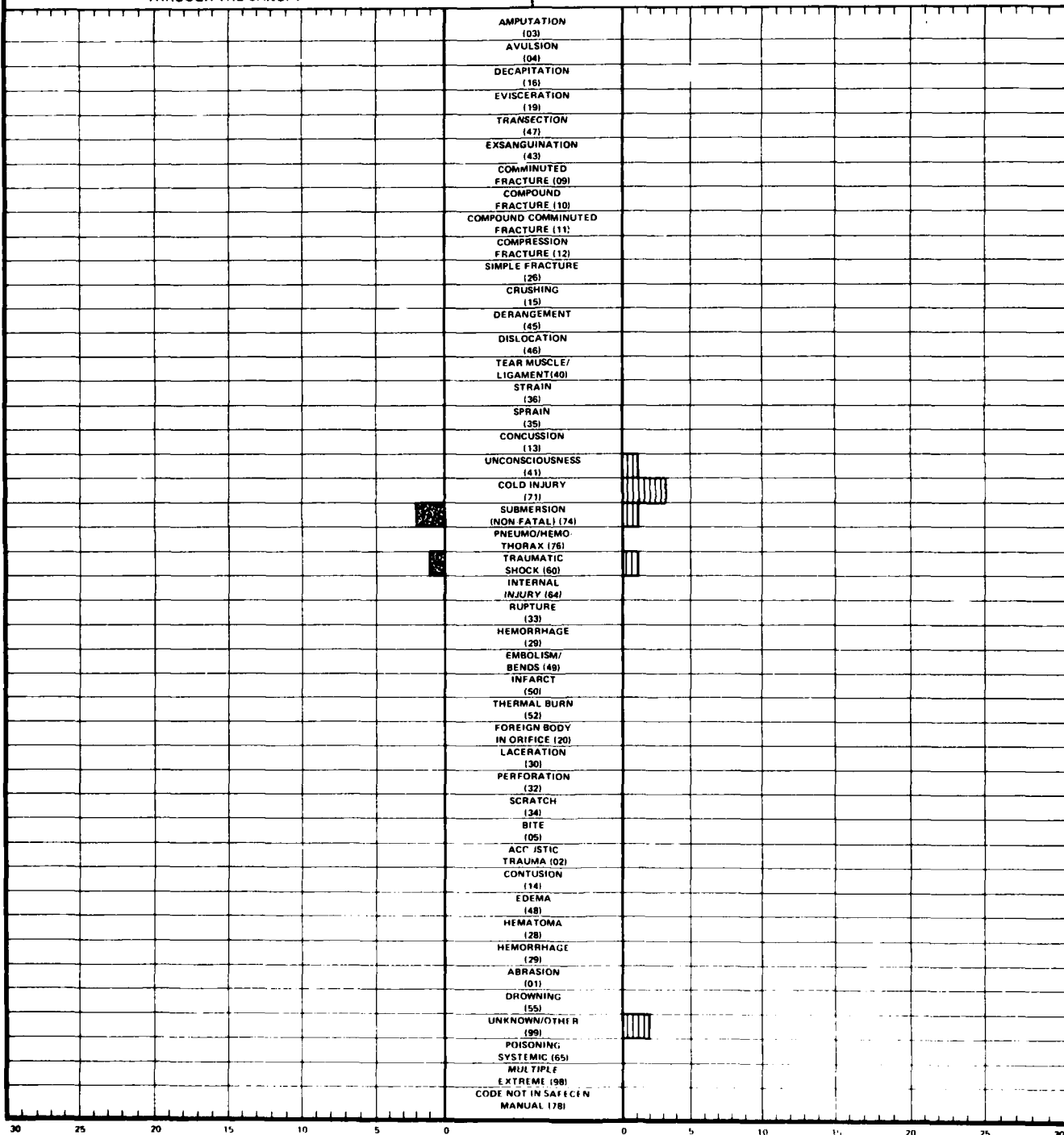
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)

BODY PART: TOTAL BODY

OF SURVIVORS - 178
THROUGH-THE-CANOPY

OF SURVIVORS - 841
JETTISONED-CANOPY

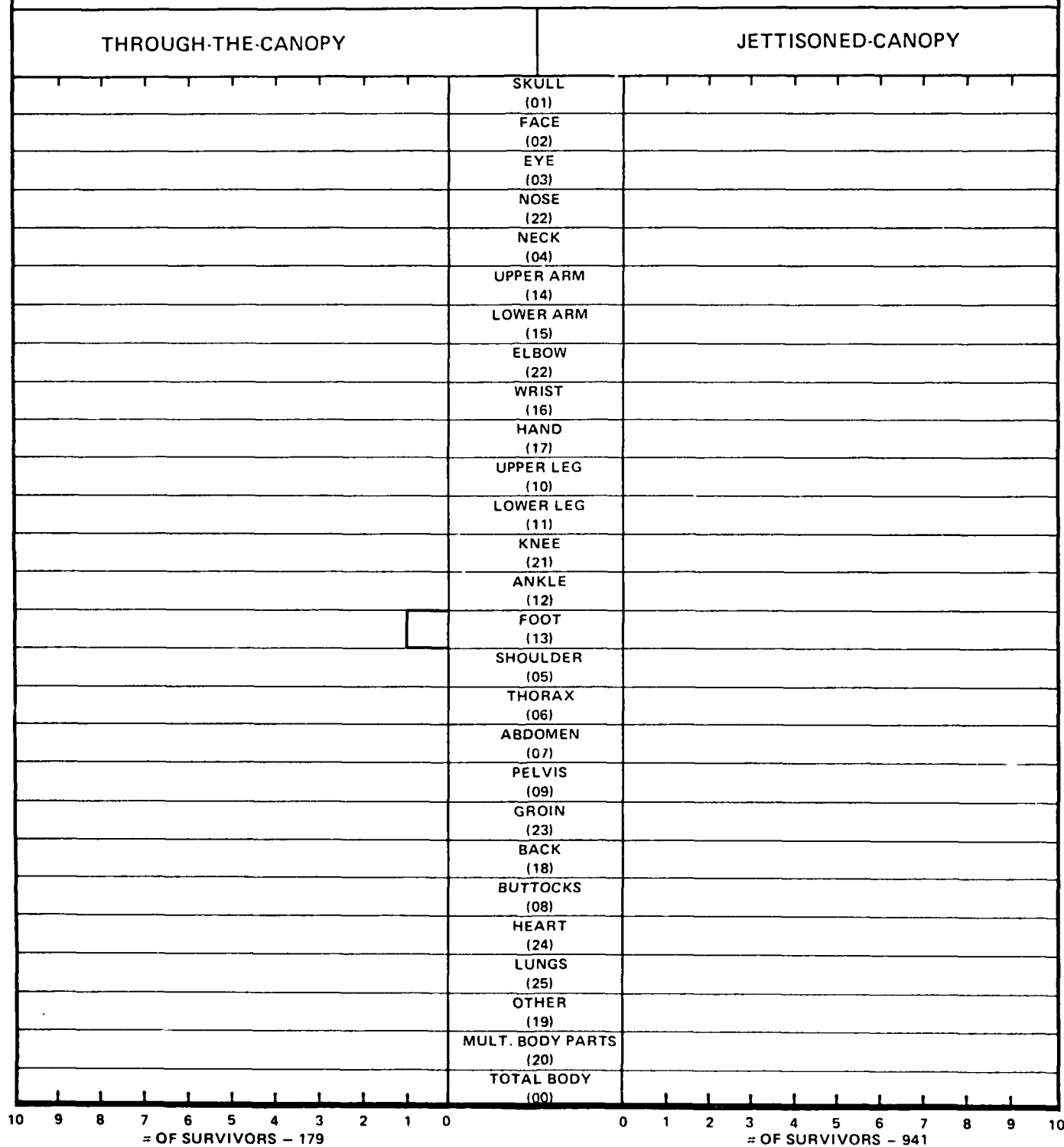


JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

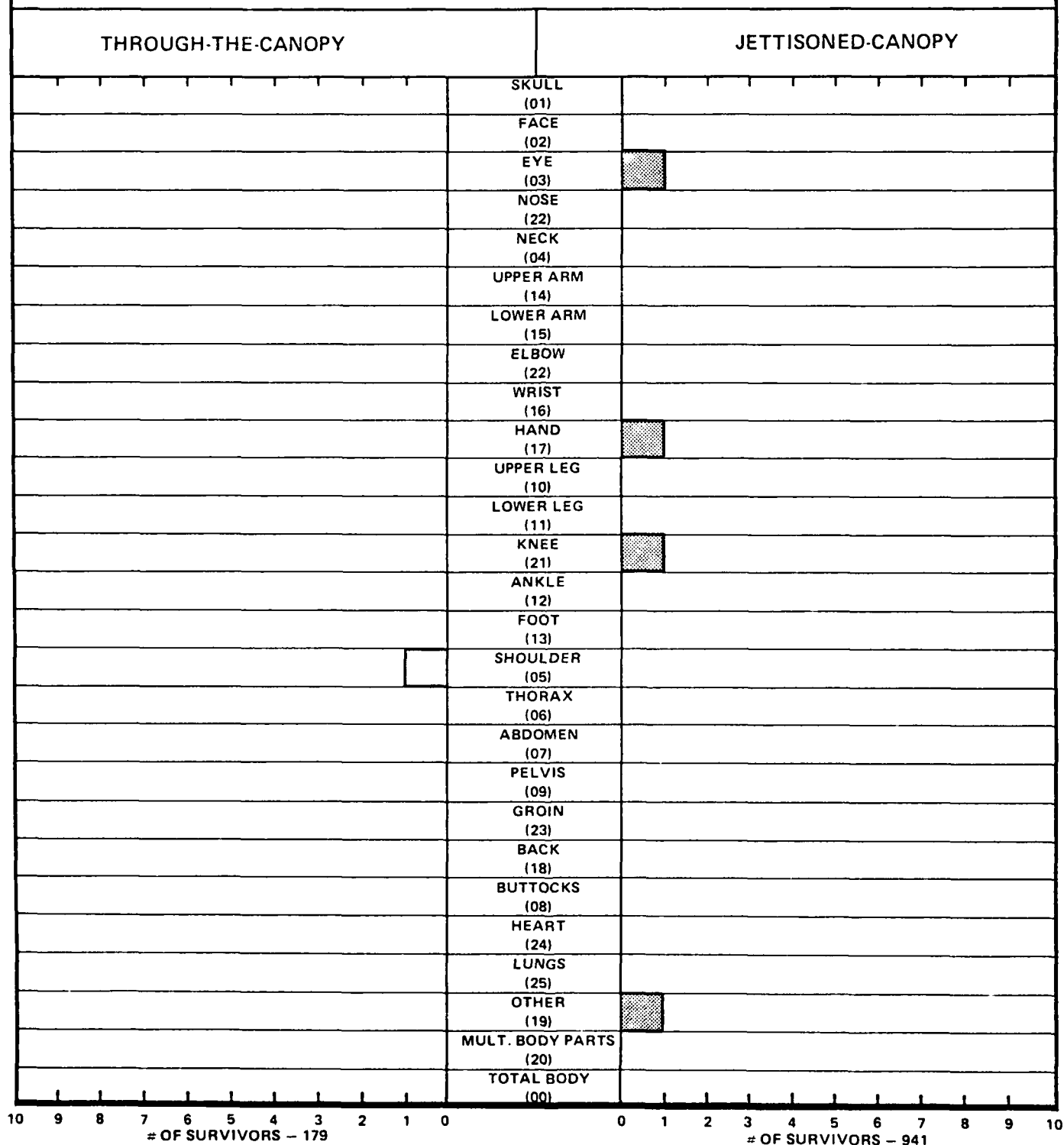
INJURY DIAGNOSIS: AMPUTATION



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

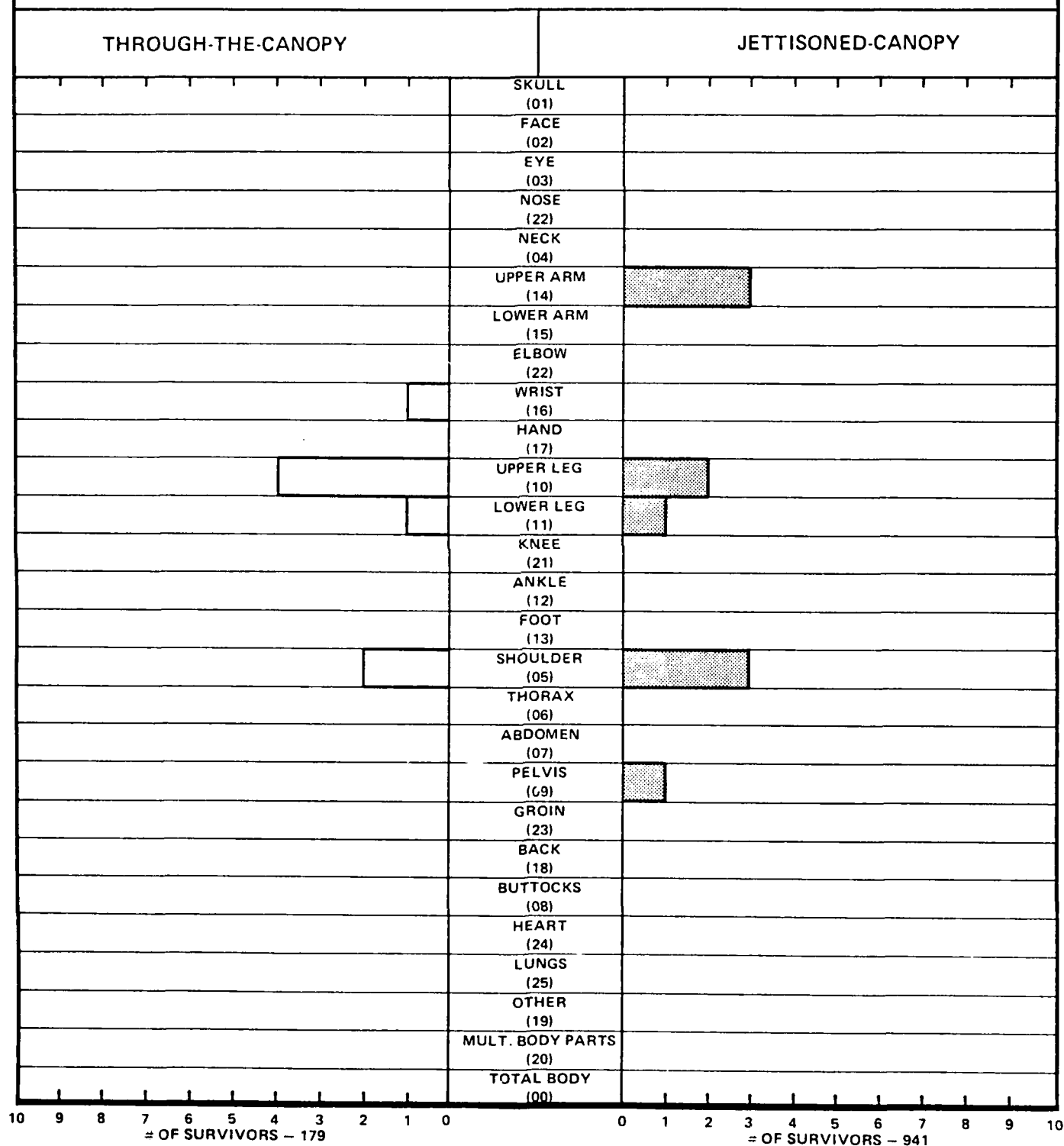
INJURY DIAGNOSIS: AVULSION



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

**INJURY DIAGNOSIS: COMMINUTED
FRACTURE**



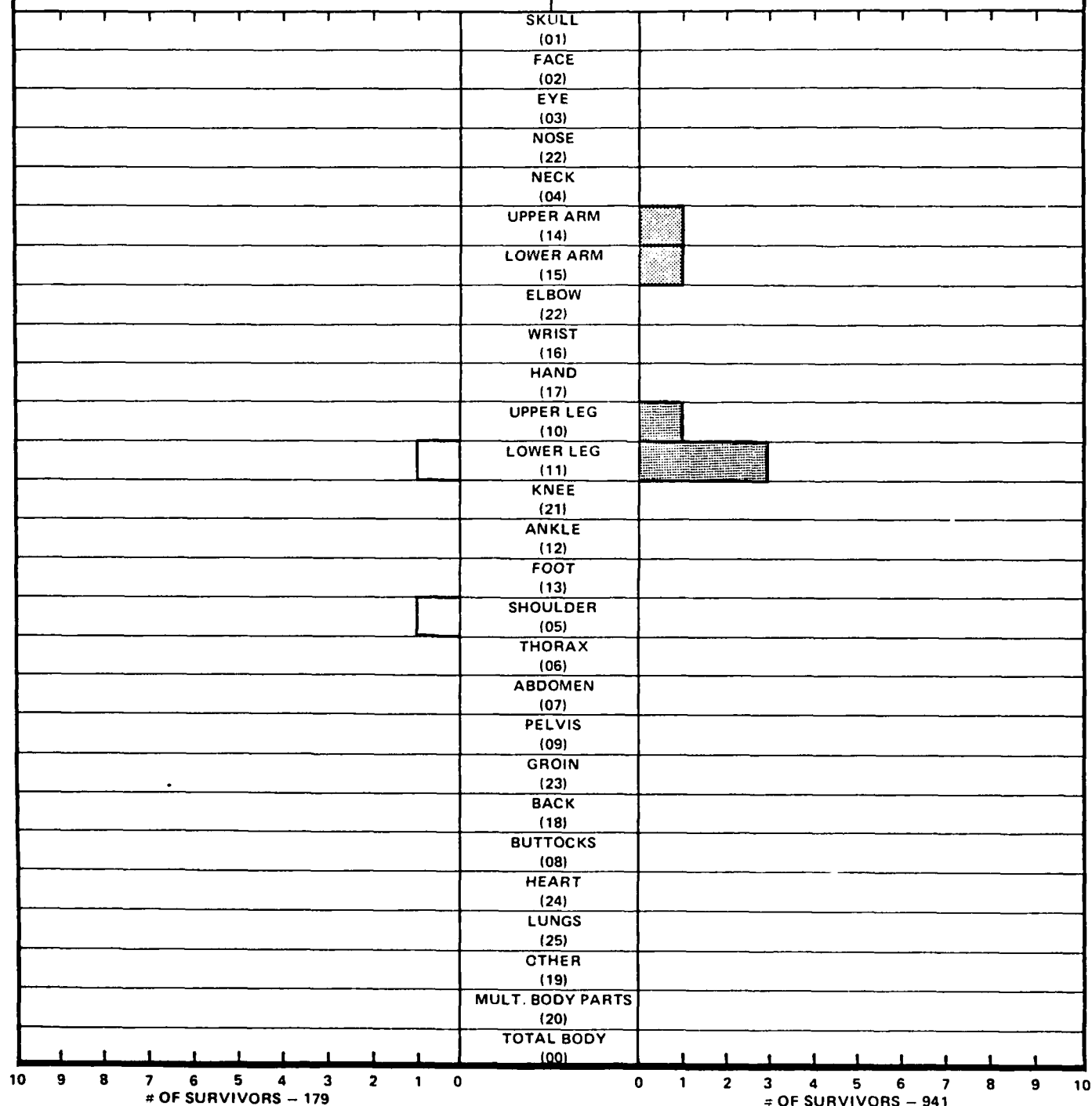
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

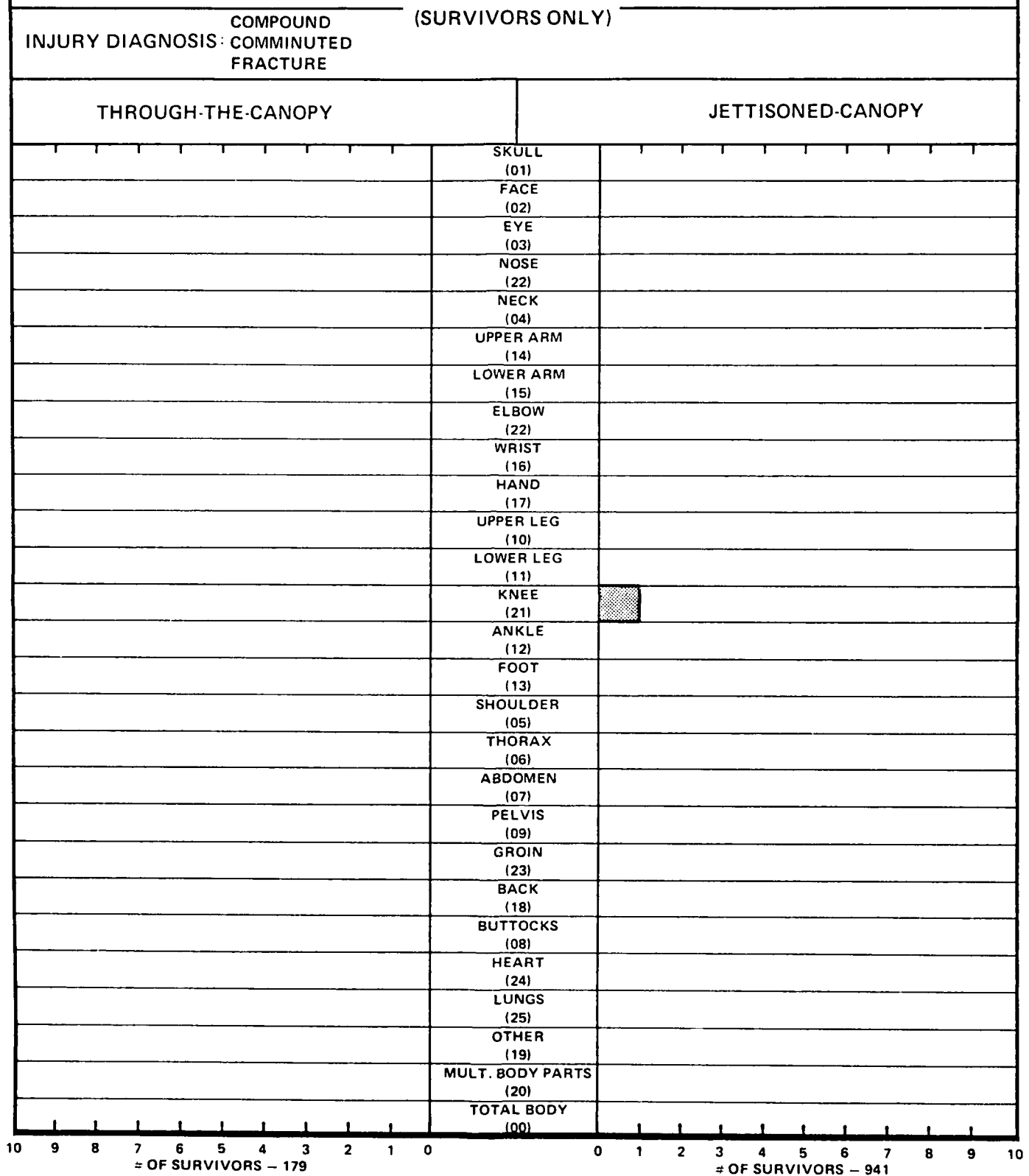
INJURY DIAGNOSIS: COMPOUND
FRACTURE

THROUGH-THE-CANOPY

JETTISONED-CANOPY

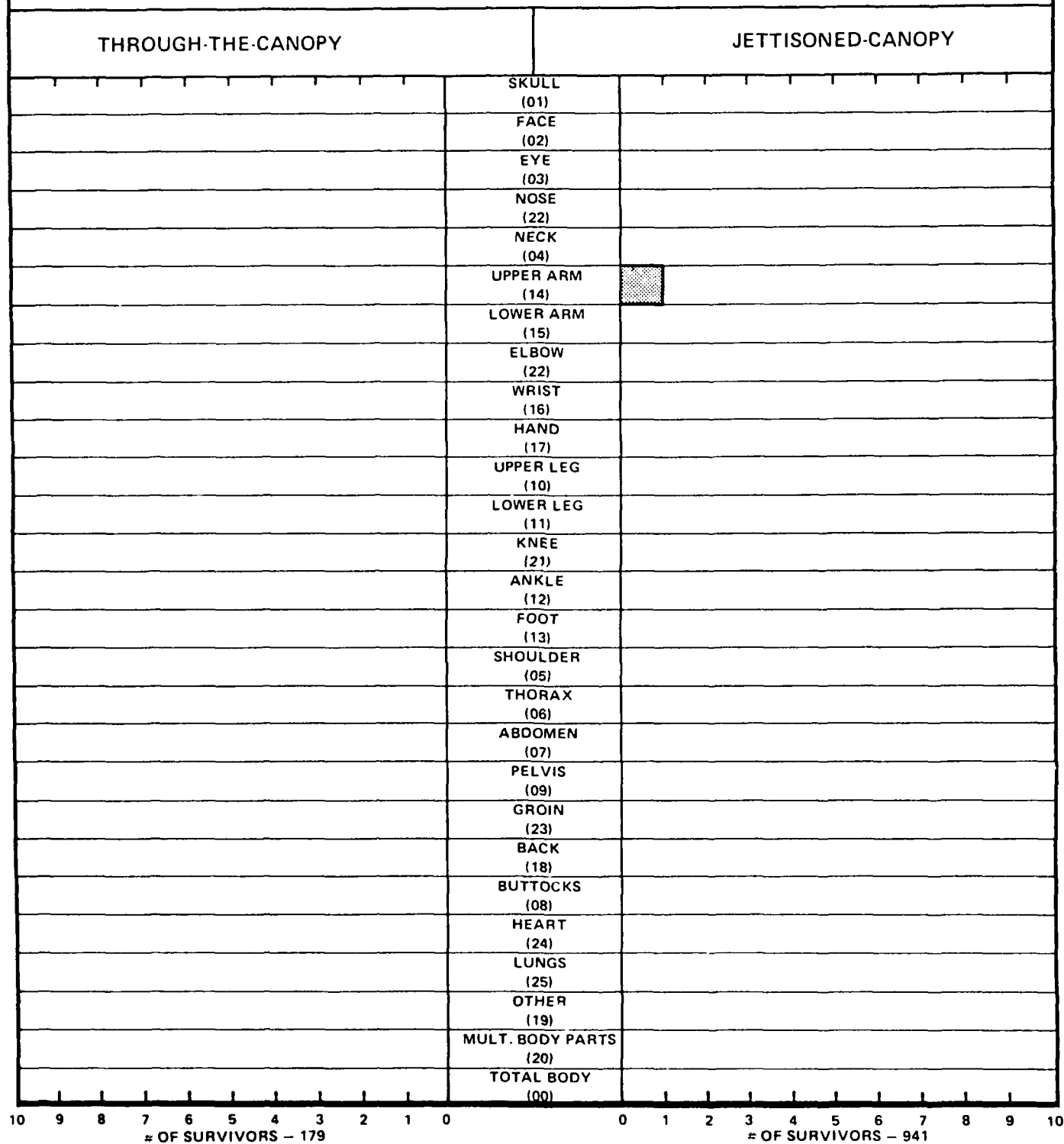


**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

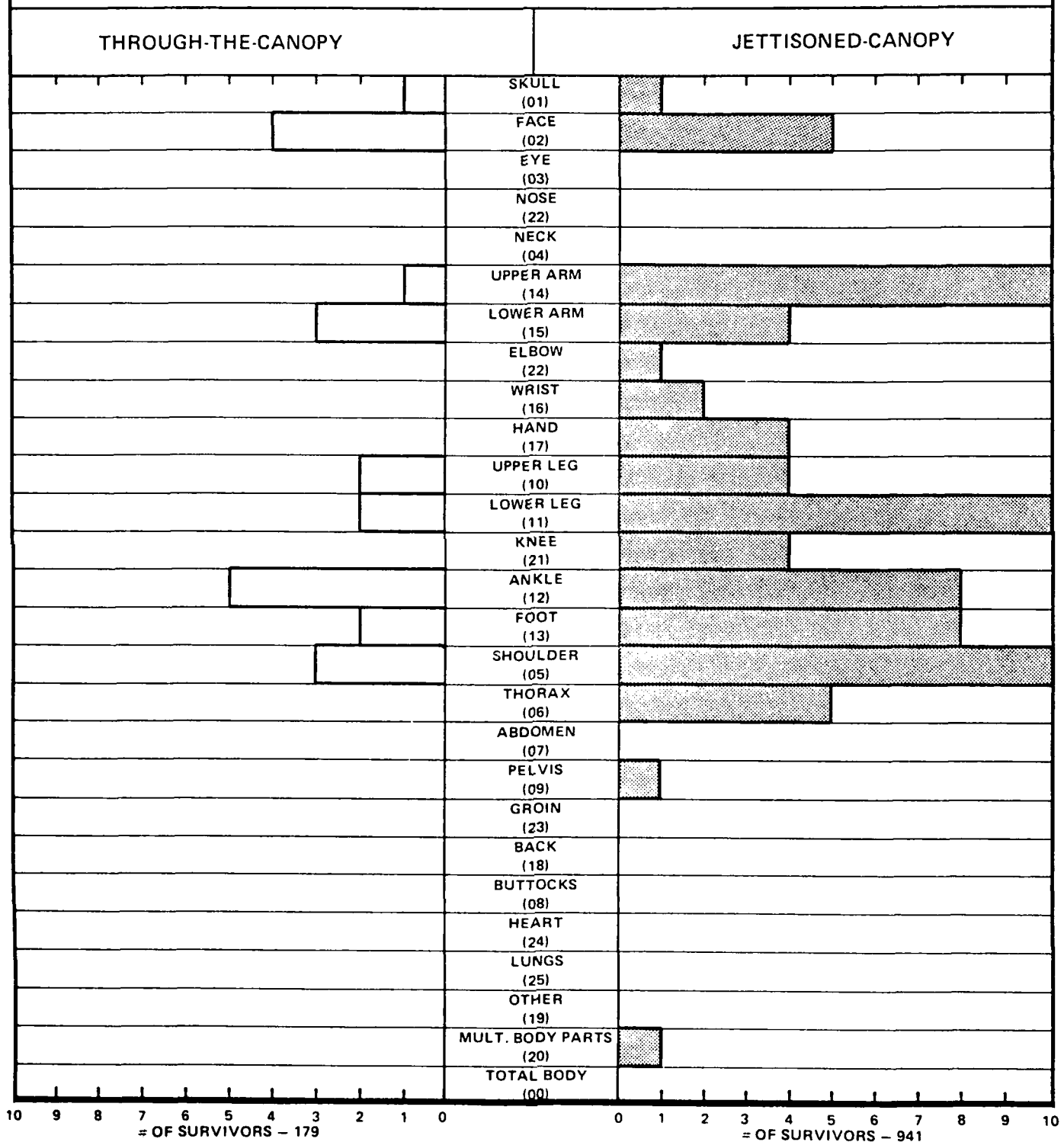
(SURVIVORS ONLY)

INJURY DIAGNOSIS: COMPRESSION
FRACTURE

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

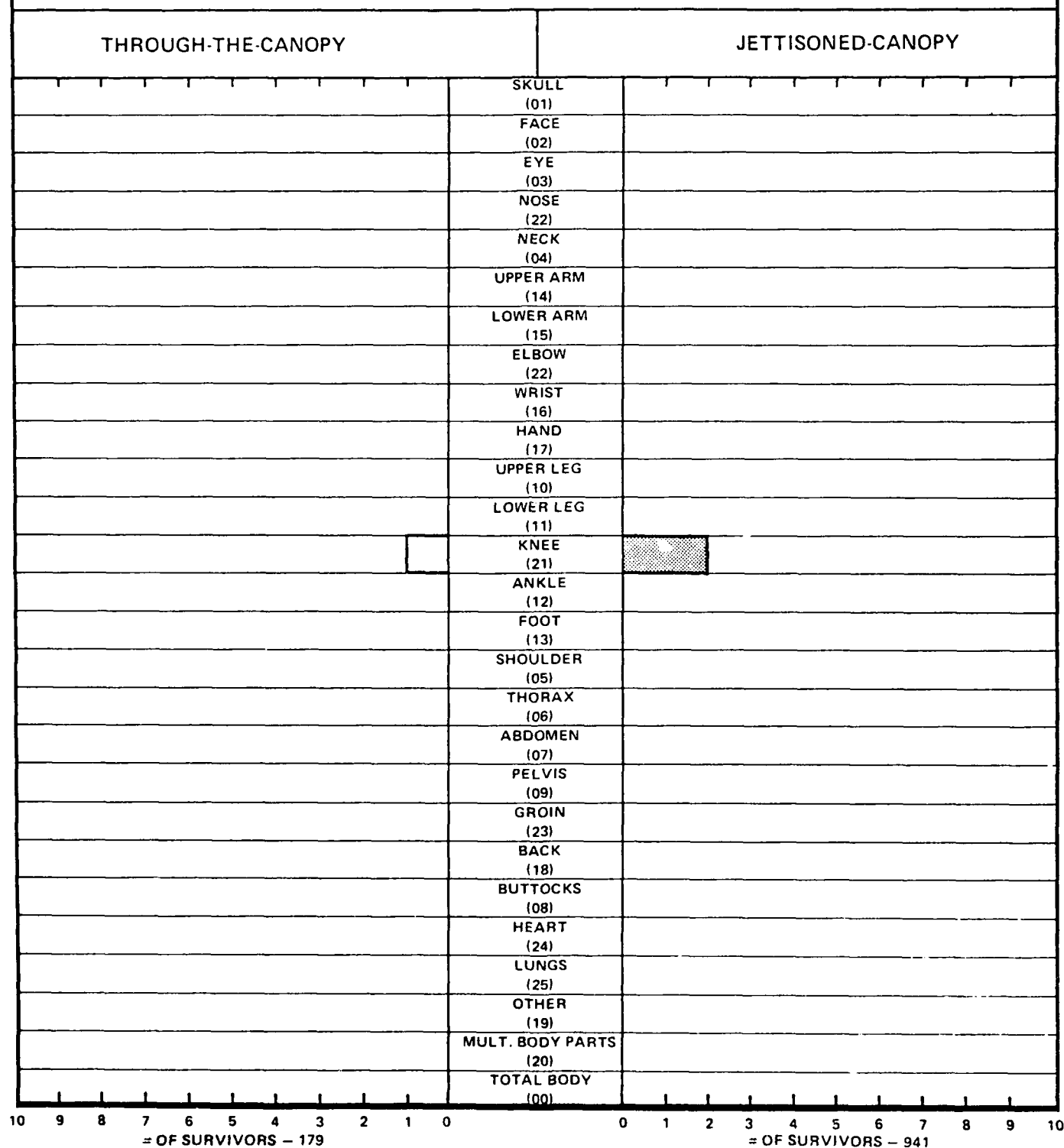
INJURY DIAGNOSIS: SIMPLE FRACTURE



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS: DERANGEMENT



ND-A171 659

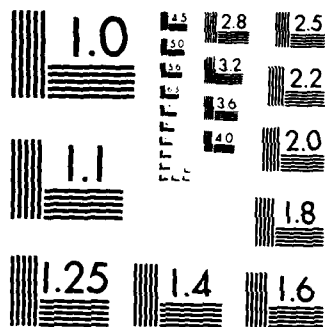
**AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS
PROGRAM SYMPOSIUM H. (U) NAVAL SAFETY CENTER NORFOLK VA
1981**

2/4

UNCLASSIFIED

F/G 1/3

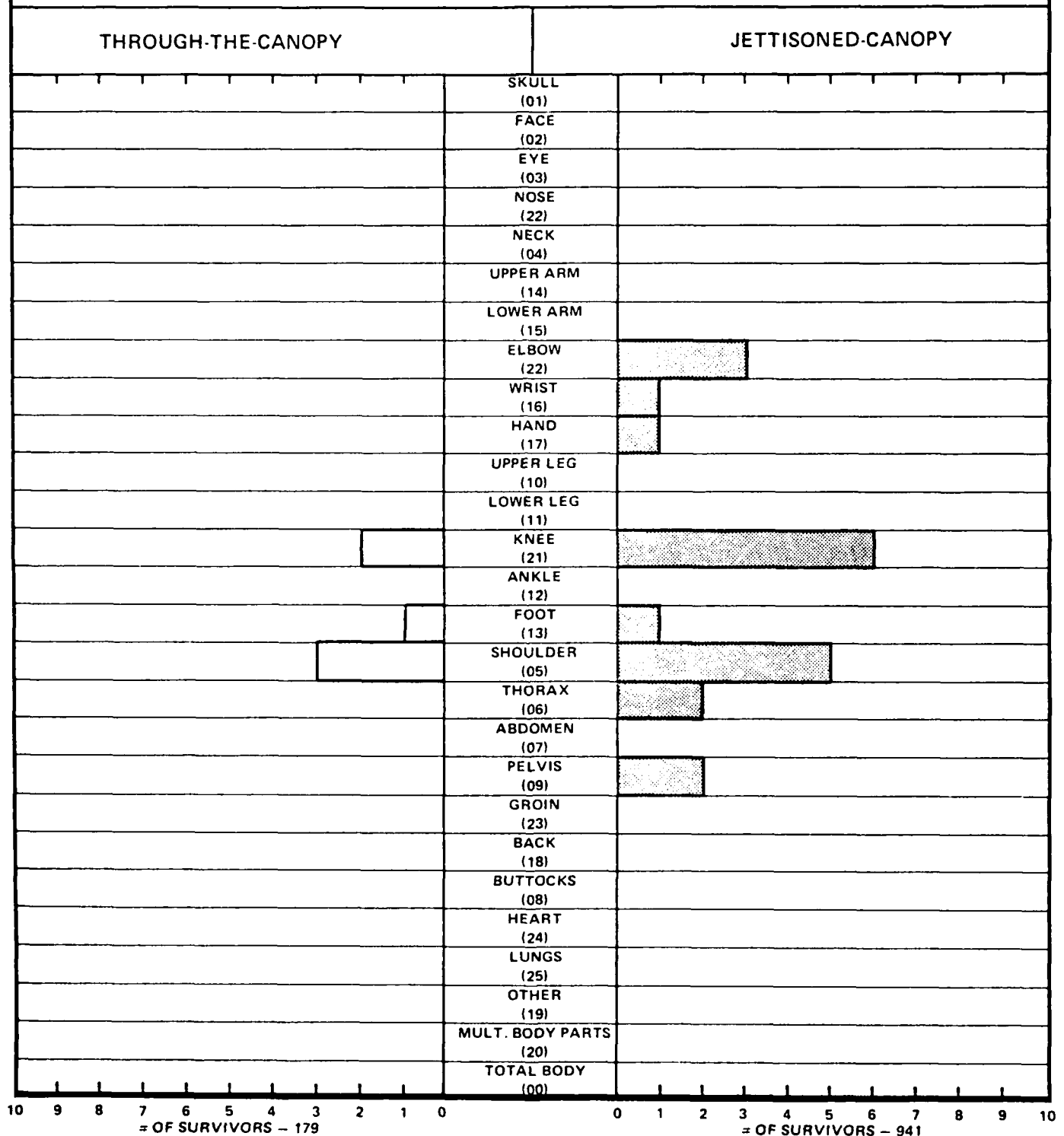
ML



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

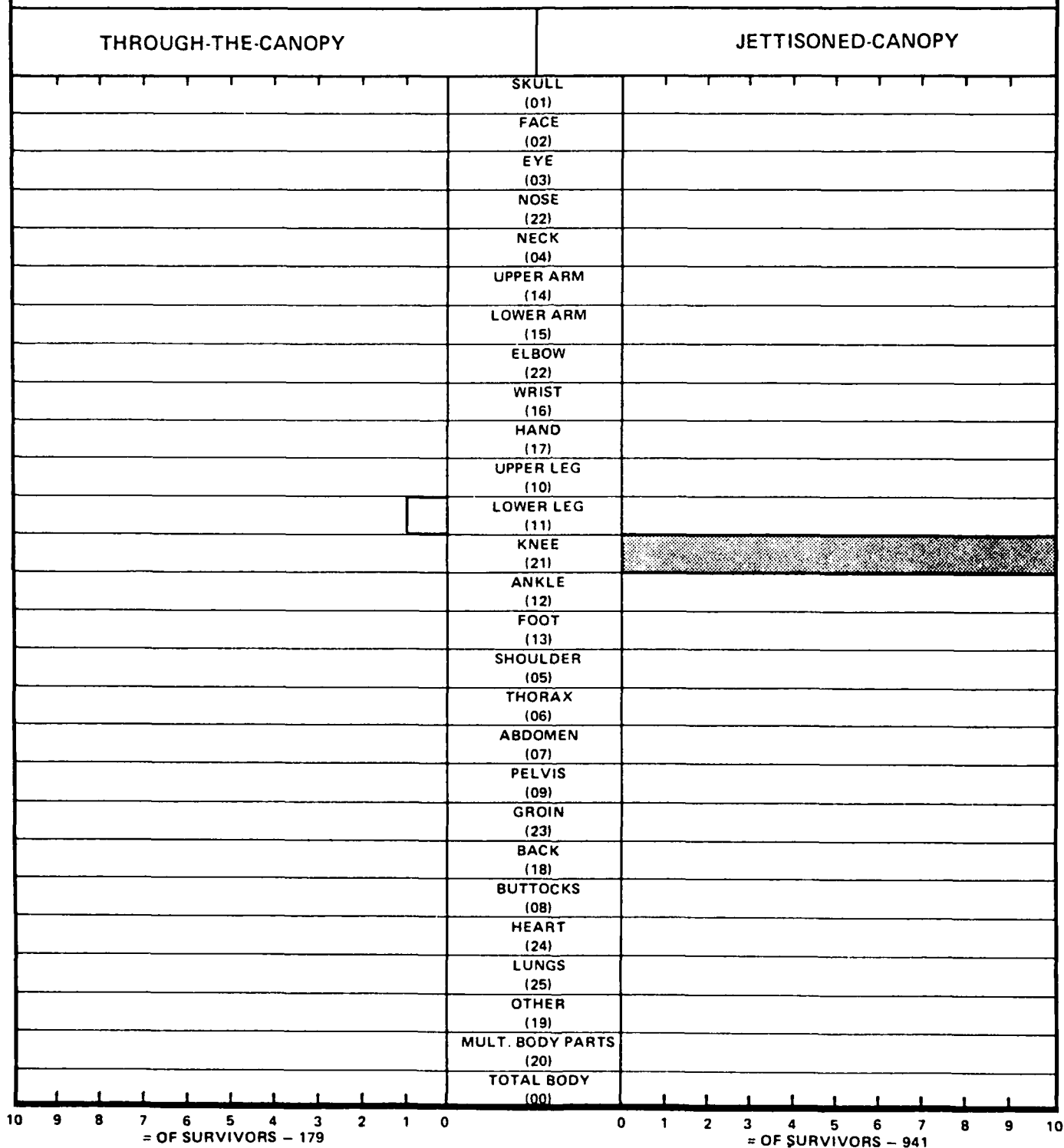
**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS
(SURVIVORS ONLY)**

INJURY DIAGNOSIS: DISLOCATION



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS: TEAR MUSCLE/
LIGAMENT

JANUARY 1969 - DECEMBER 1979

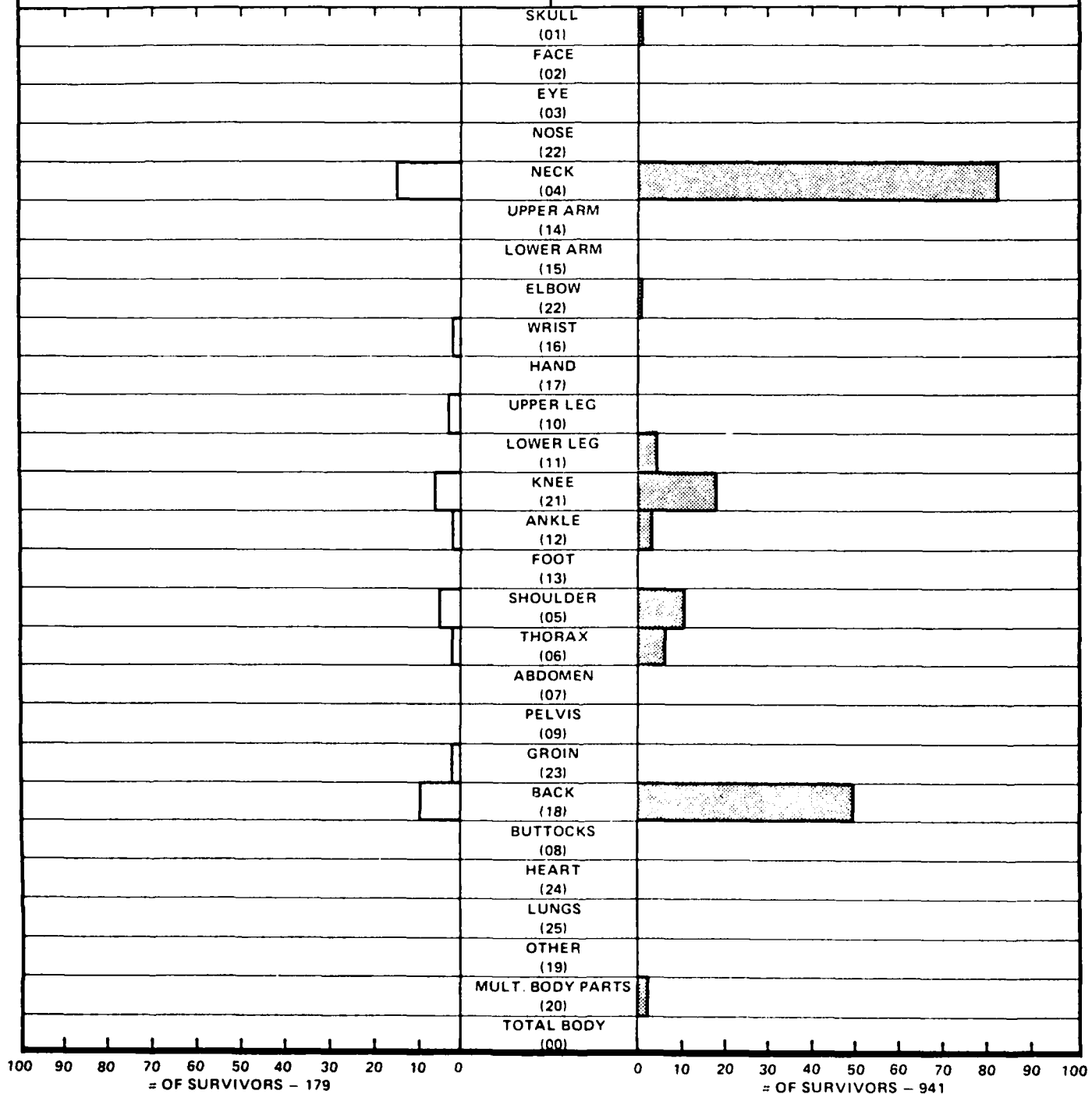
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: STRAIN

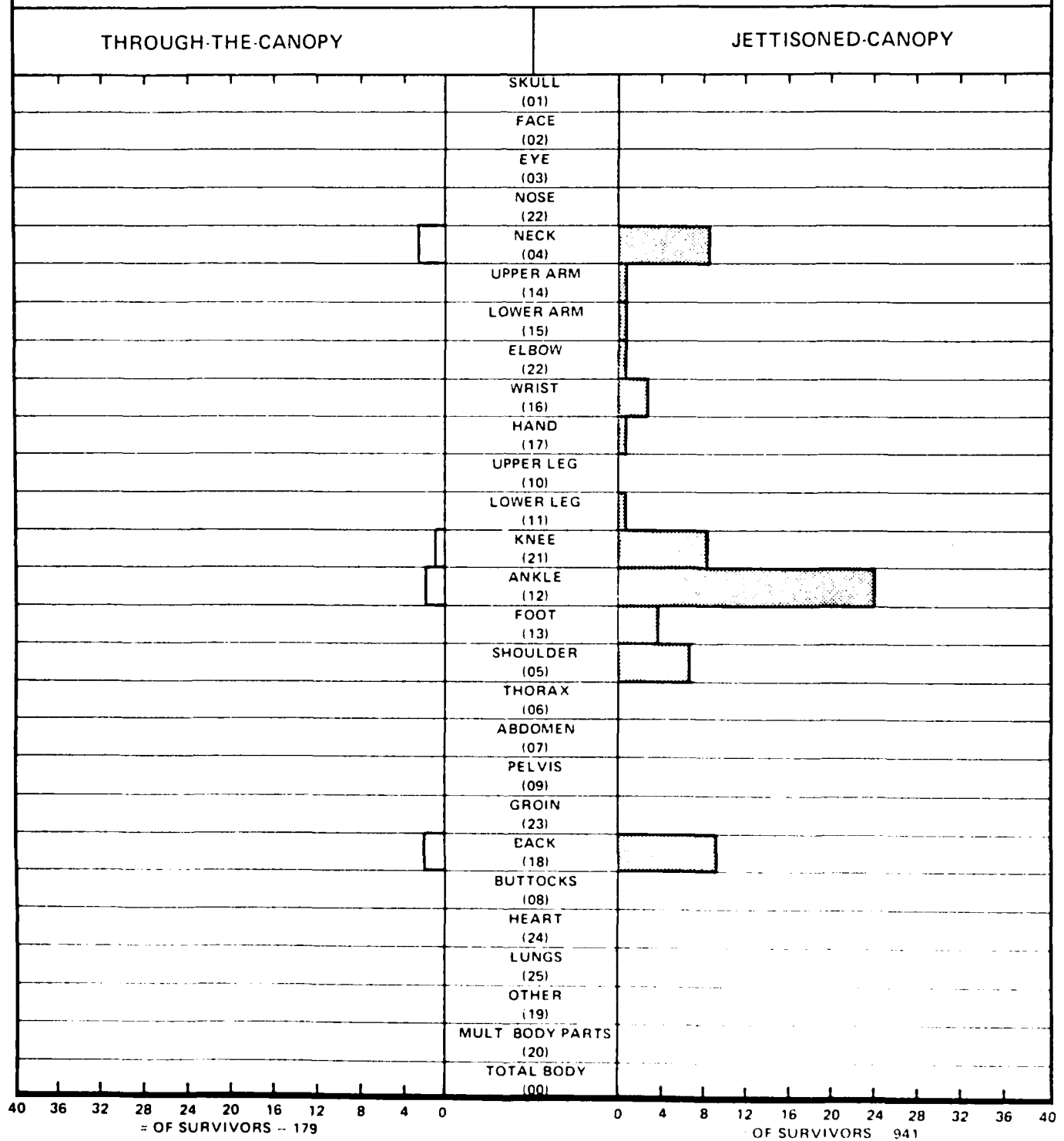
THROUGH-THE-CANOPY

JETTISONED-CANOPY



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: **SPRAIN**

JANUARY 1969 – DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

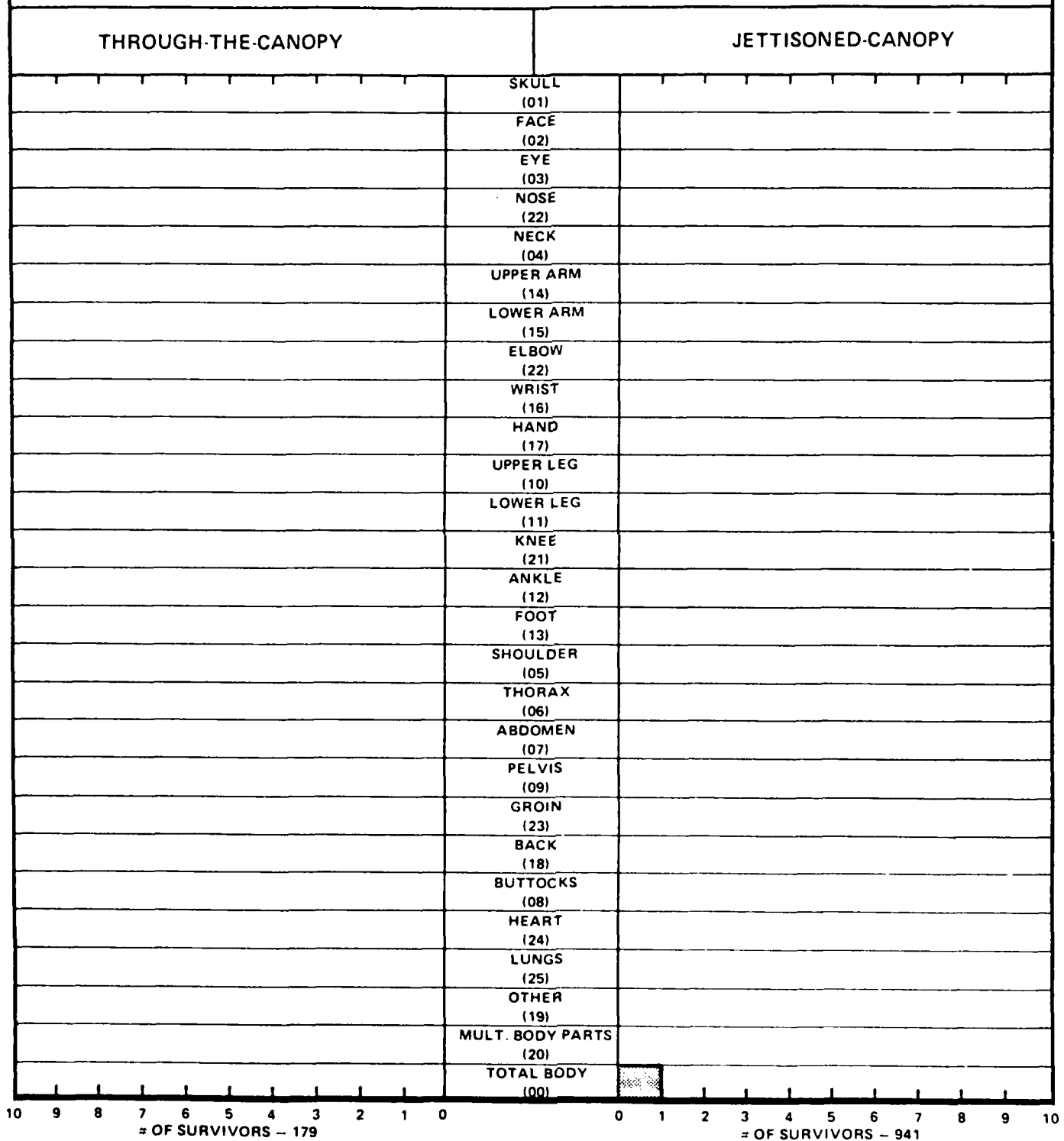
INJURY DIAGNOSIS: CONCUSSION

THROUGH-THE-CANOPY											JETTISONED-CANOPY										
											SKULL (01)										
											FACE (02)										
											EYE (03)										
											NOSE (22)										
											NECK (04)										
											UPPER ARM (14)										
											LOWER ARM (15)										
											ELBOW (22)										
											WRIST (16)										
											HAND (17)										
											UPPER LEG (10)										
											LOWER LEG (11)										
											KNEE (21)										
											ANKLE (12)										
											FOOT (13)										
											SHOULDER (05)										
											THORAX (06)										
											ABDOMEN (07)										
											PELVIS (09)										
											GROIN (23)										
											BACK (18)										
											BUTTOCKS (08)										
											HEART (24)										
											LUNGS (25)										
											OTHER (19)										
											MULT. BODY PARTS (20)										
											TOTAL BODY (00)										

**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS: UNCONSCIOUSNESS

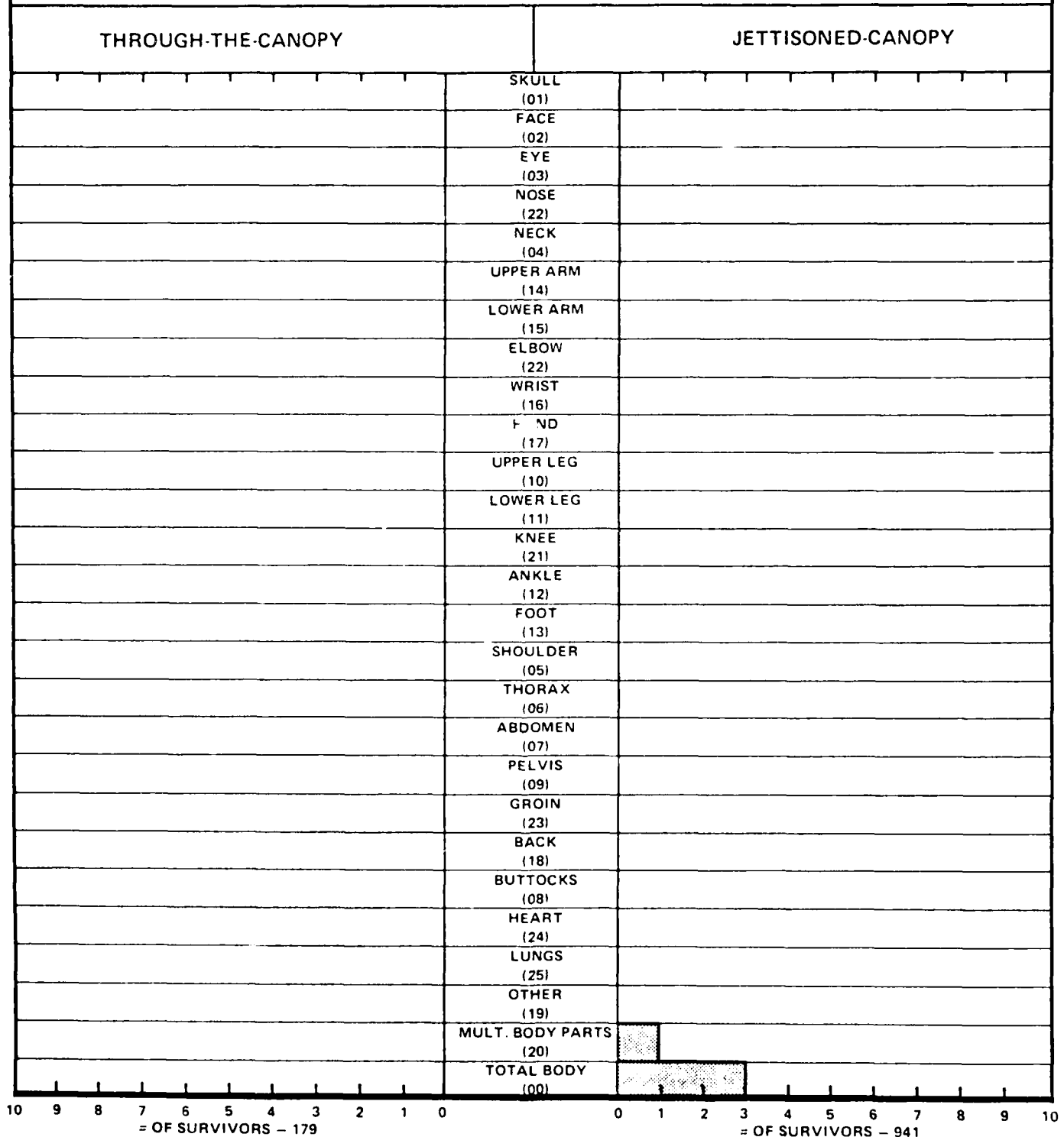


JANUARY 1969 - DECEMBER 1979

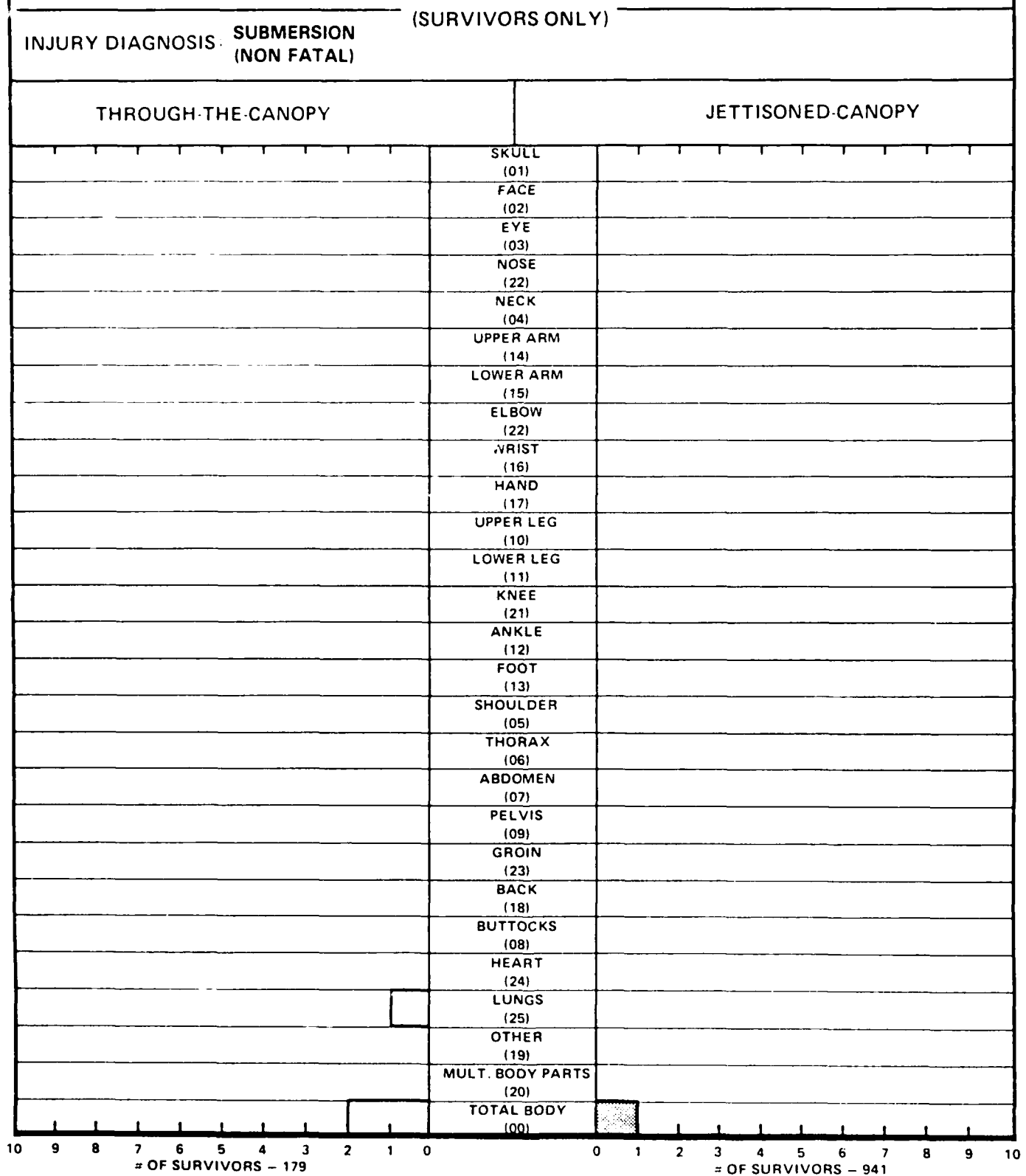
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: COLD INJURY

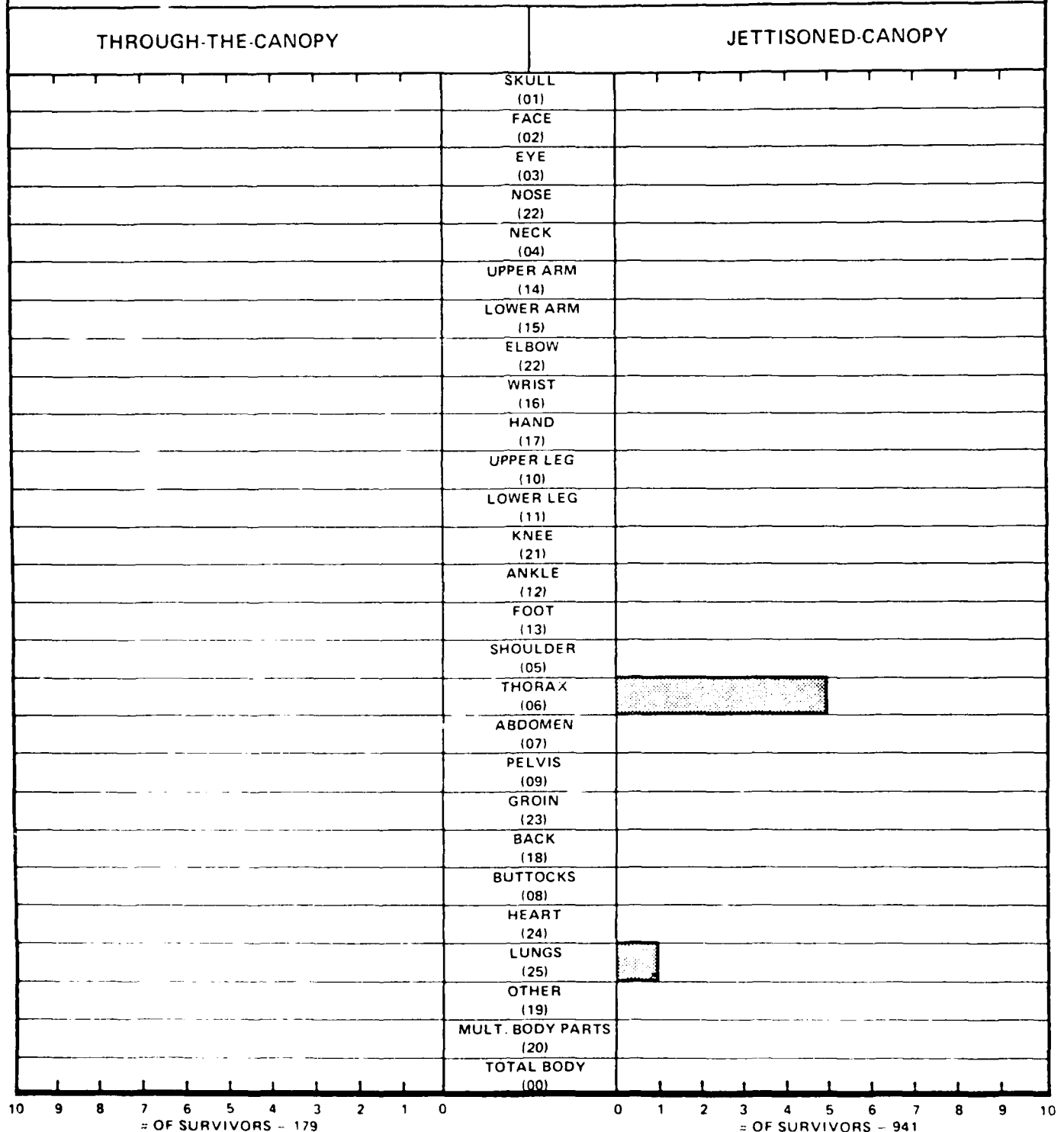


**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

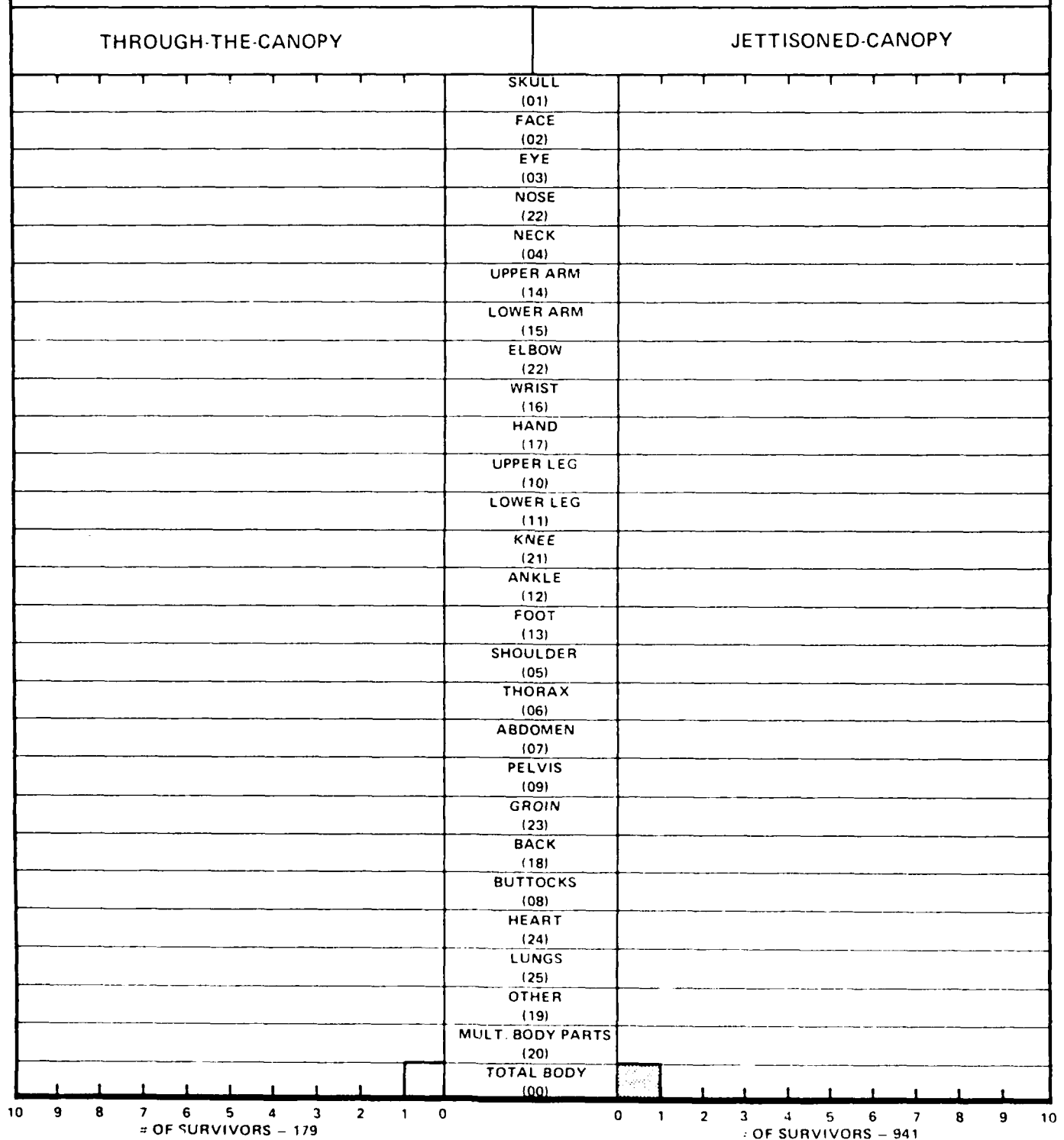
INJURY DIAGNOSIS: **PNEUMO/HEMO-THORAX** (SURVIVORS ONLY)



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

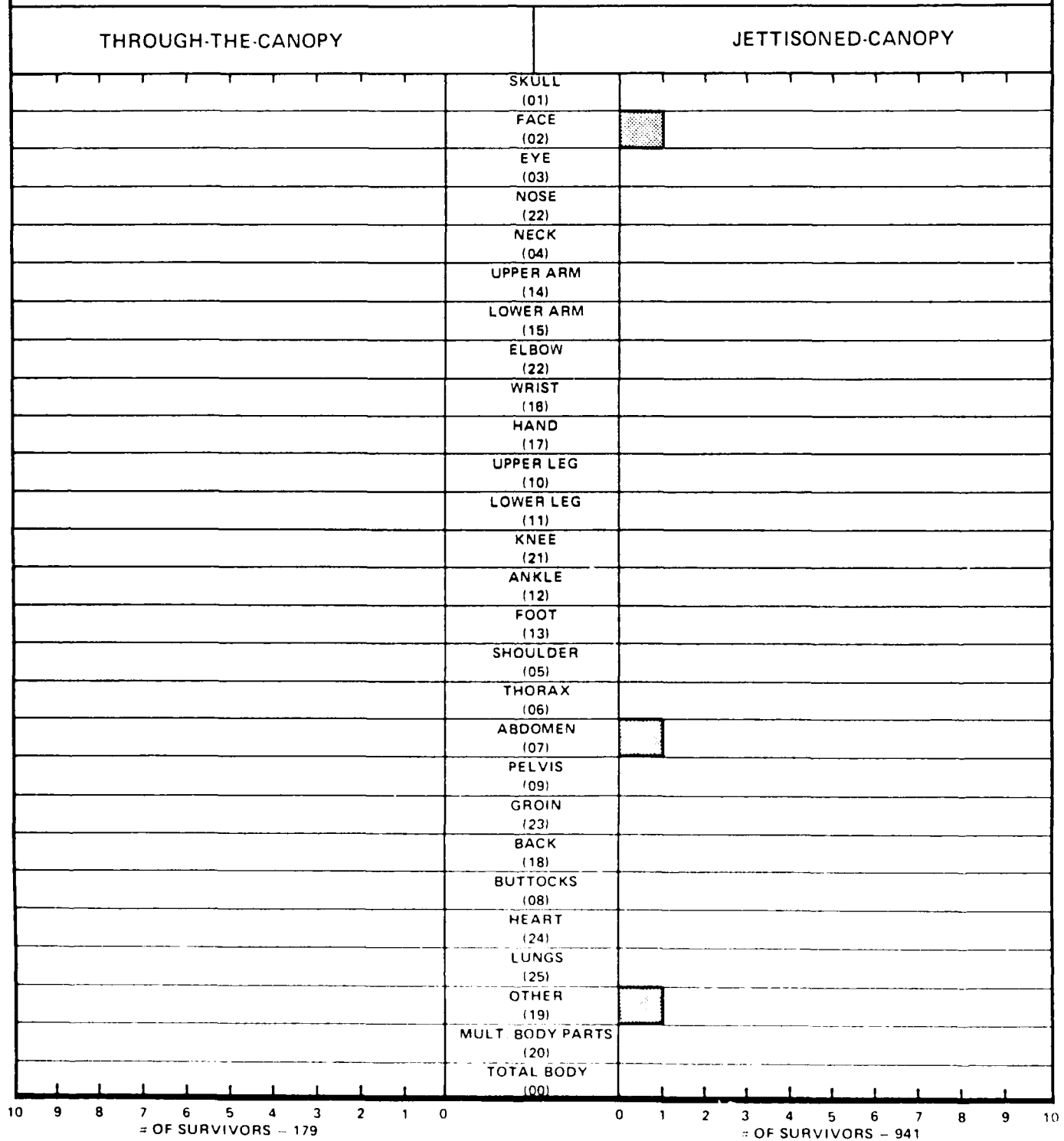
INJURY DIAGNOSIS: TRAUMATIC SHOCK



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

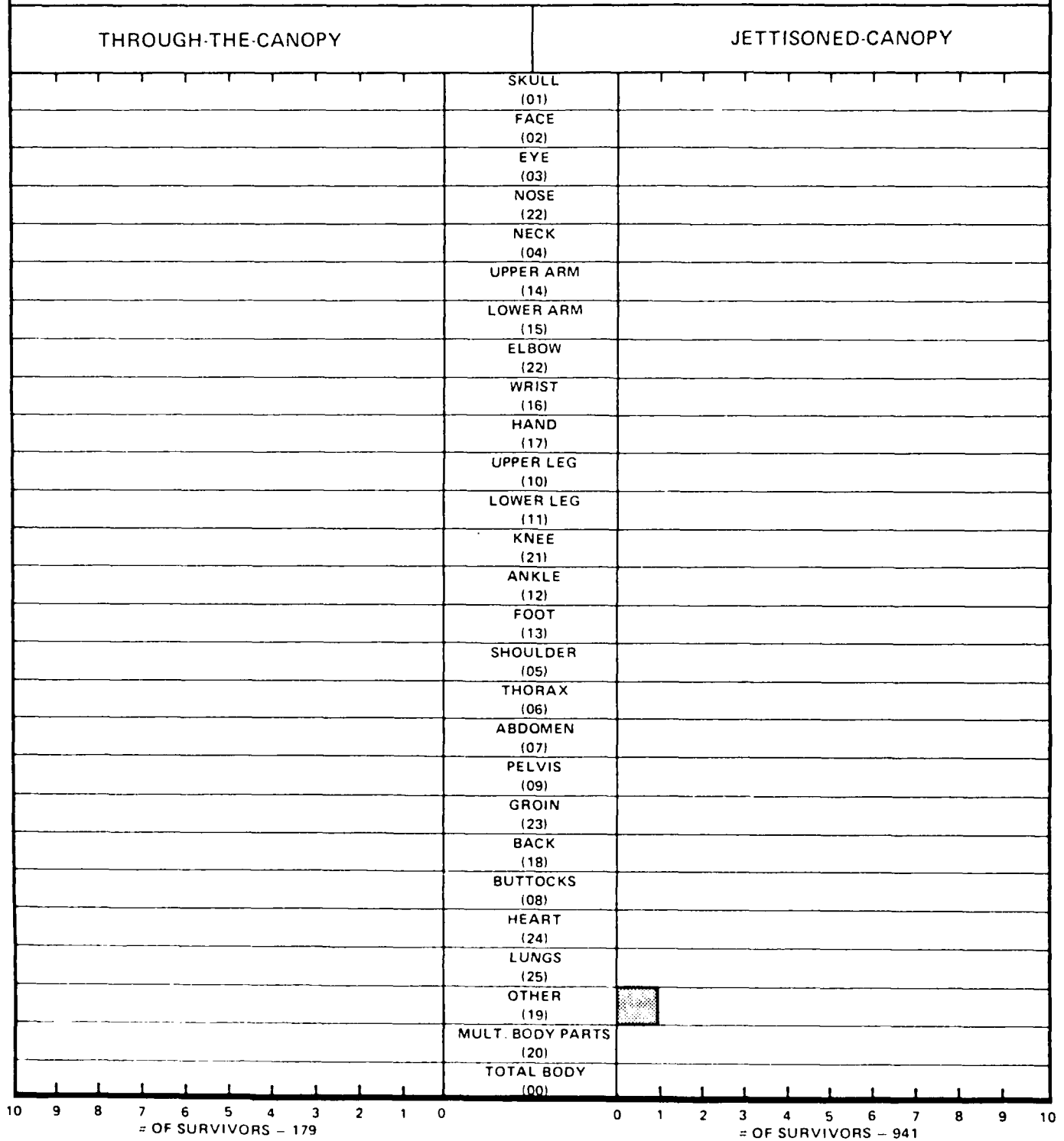
INJURY DIAGNOSIS: INTERNAL INJURY



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

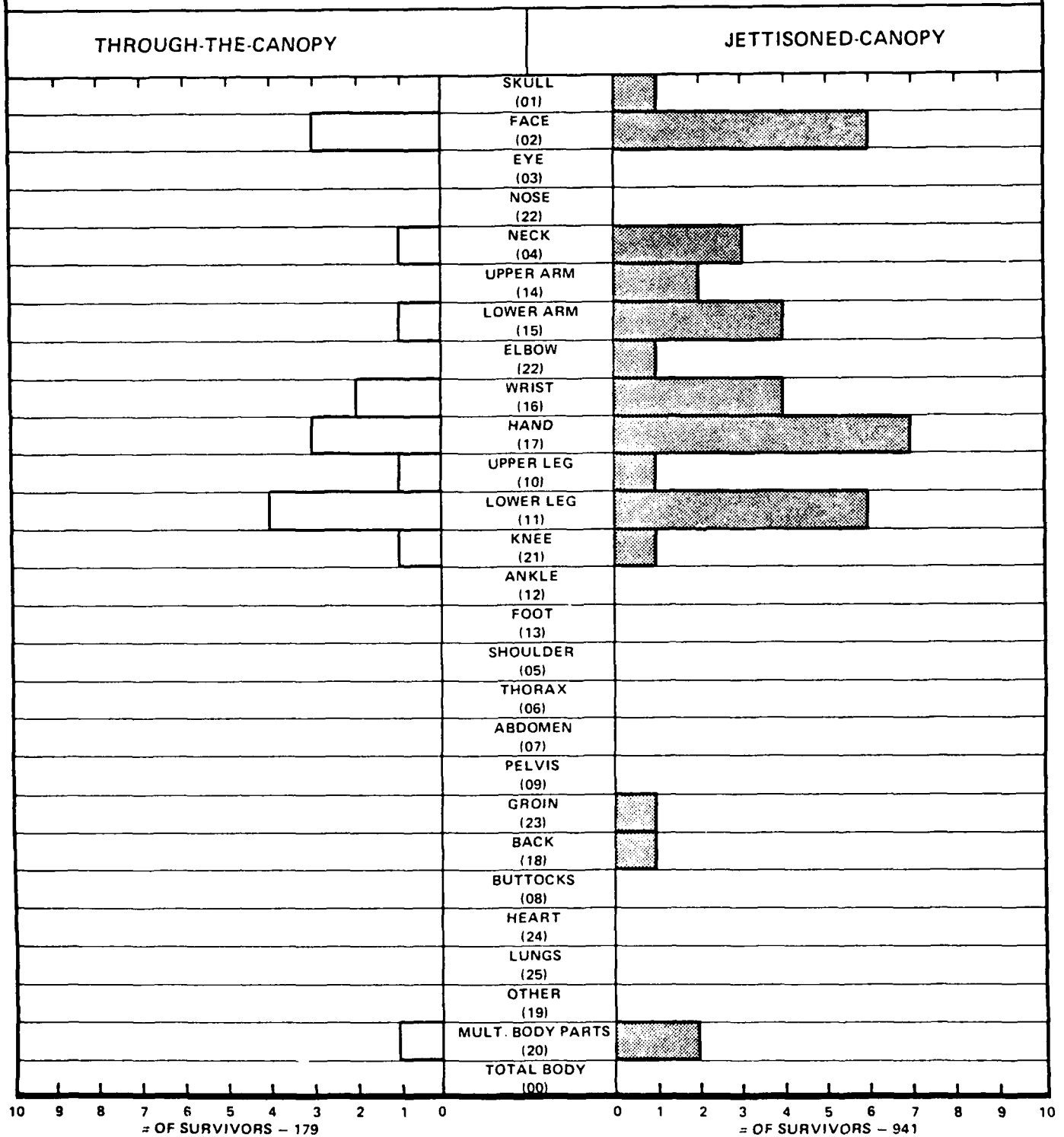
INJURY DIAGNOSIS: RUPTURE



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

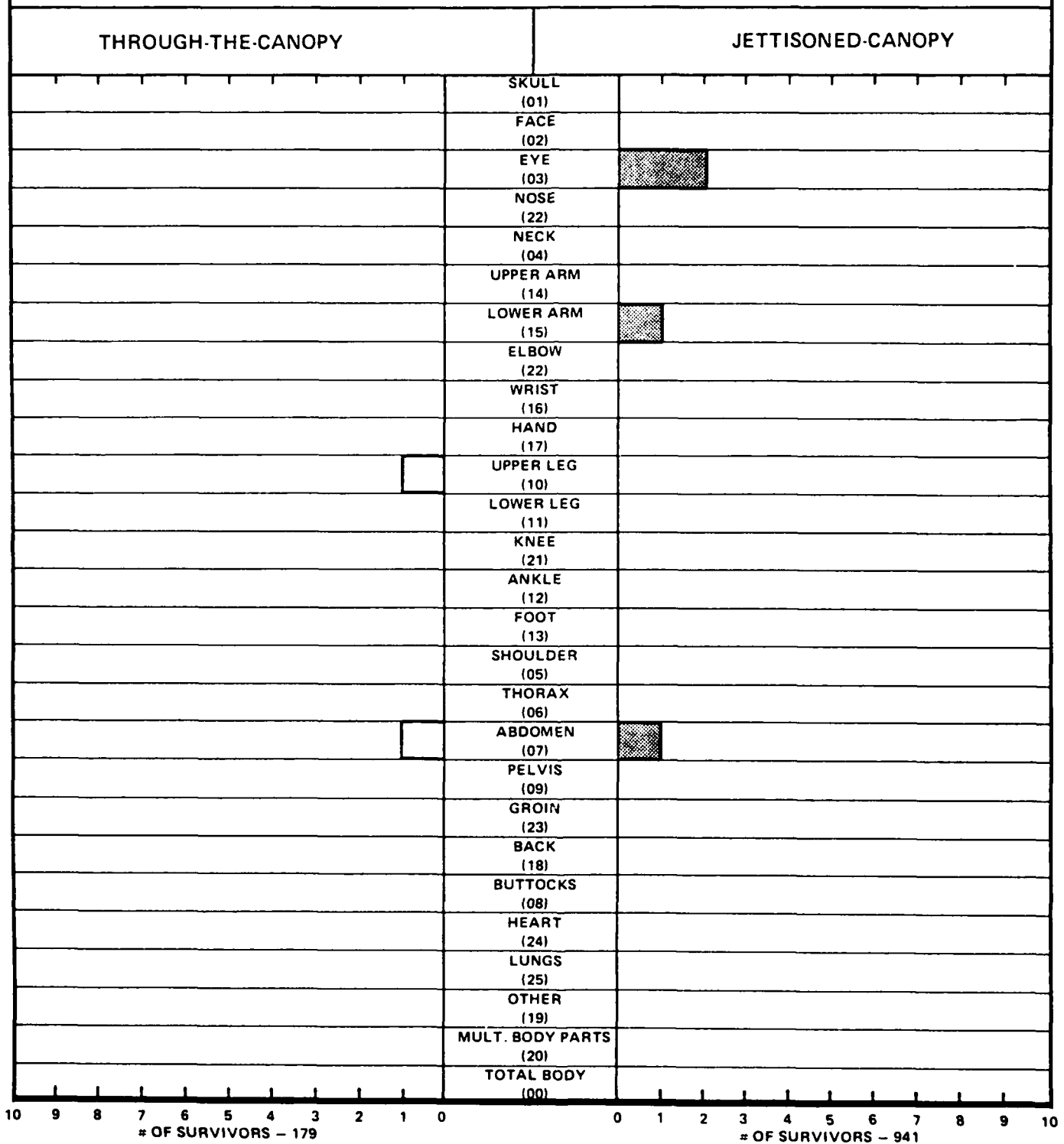
(SURVIVORS ONLY)

INJURY DIAGNOSIS: THERMAL BURN



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

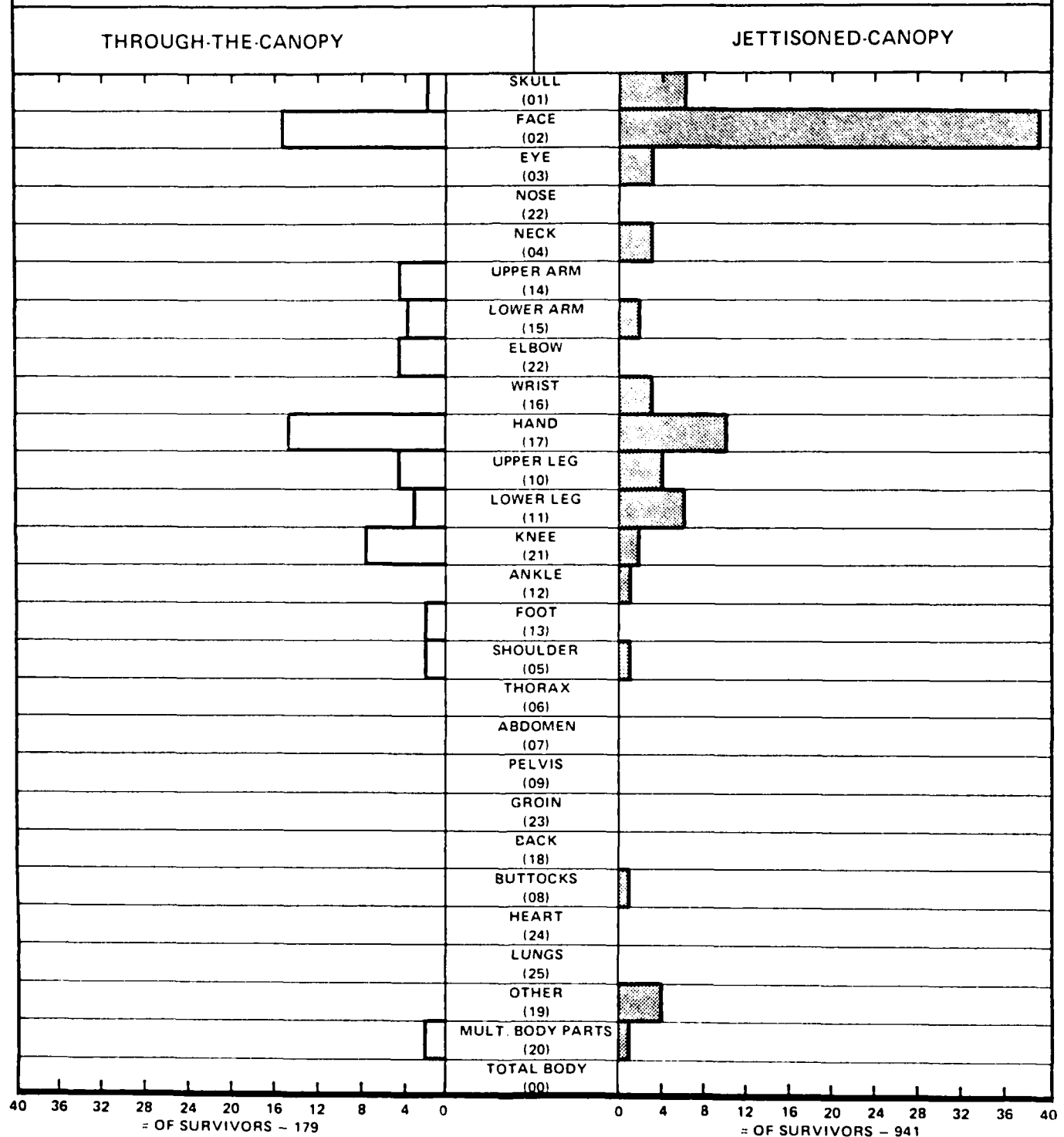
**INJURY DIAGNOSIS: FOREIGN BODY
IN ORIFICE** (SURVIVORS ONLY)



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS: LACERATION

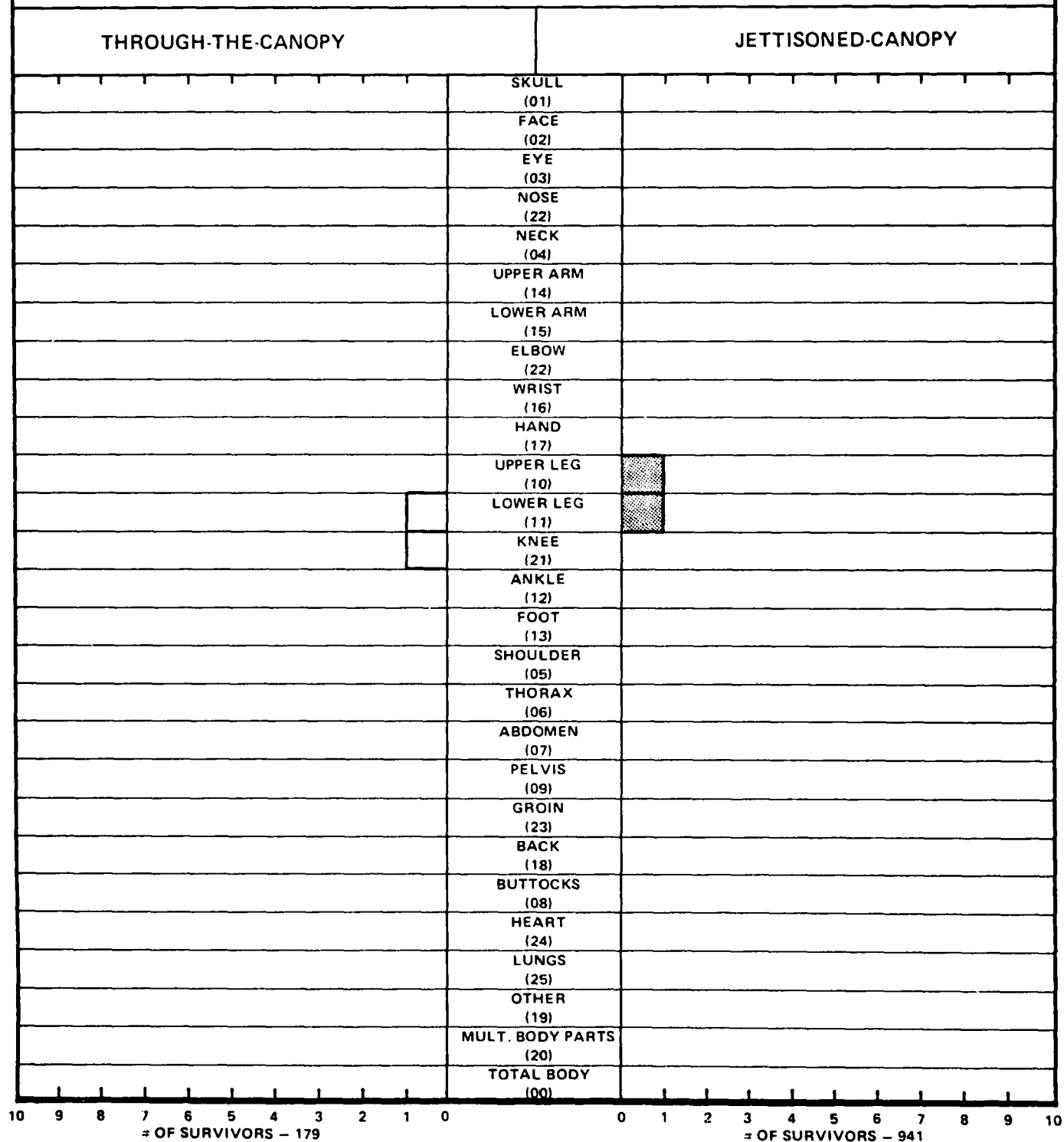


JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: PERFORATION



JANUARY 1969 – DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

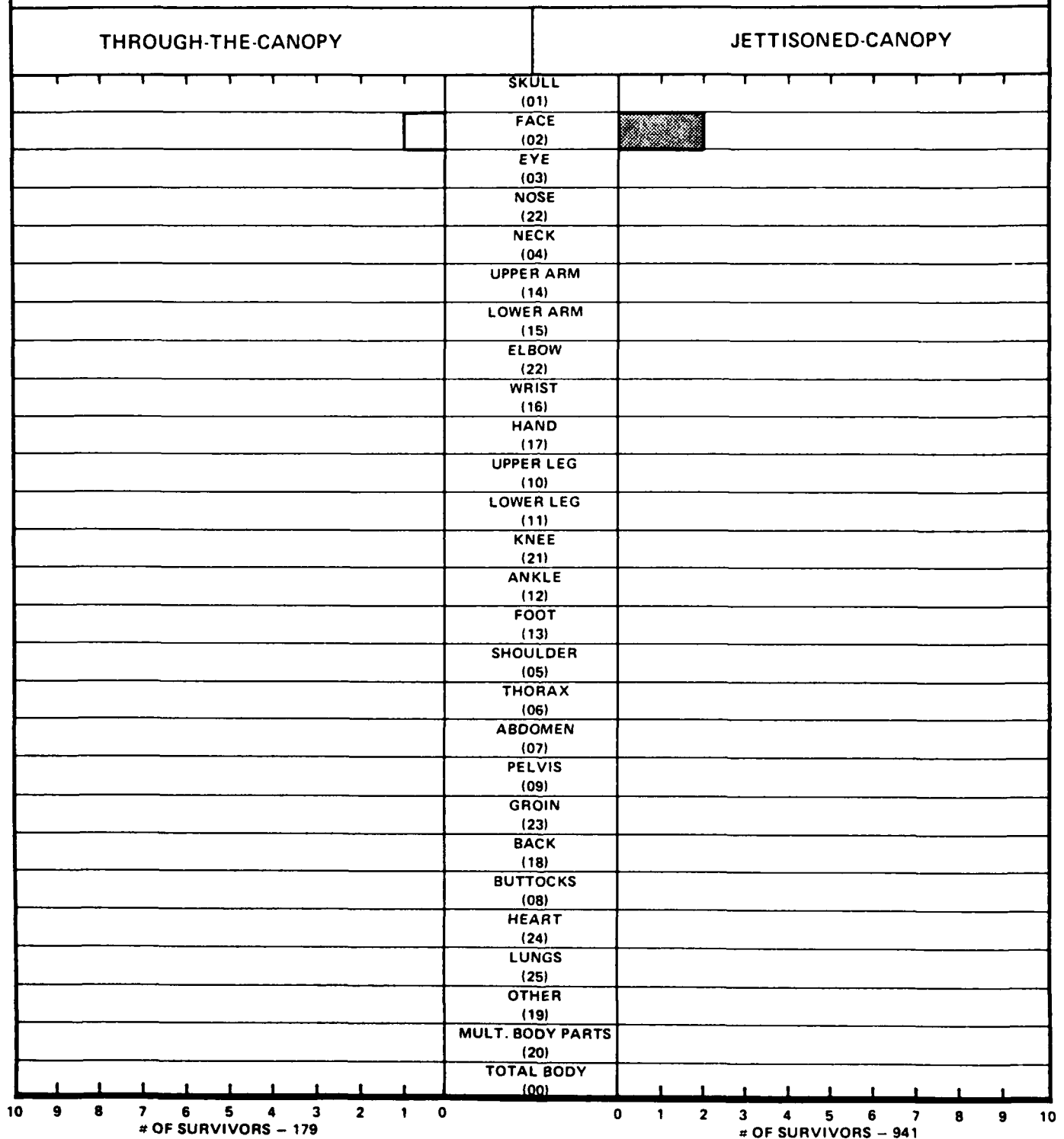
(SURVIVORS ONLY)

INJURY DIAGNOSIS: SCRATCH

THROUGH-THE-CANOPY											JETTISONED-CANOPY											
											SKULL (01)											
											FACE (02)											
											EYE (03)											
											NOSE (22)											
											NECK (04)											
											UPPER ARM (14)											
											LOWER ARM (15)											
											ELBOW (22)											
											WRIST (16)											
											HAND (17)											
											UPPER LEG (10)											
											LOWER LEG (11)											
											KNEE (21)											
											ANKLE (12)											
											FOOT (13)											
											SHOULDER (05)											
											THORAX (06)											
											ABDOMEN (07)											
											PELVIS (09)											
											GROIN (23)											
											BACK (18)											
											BUTTOCKS (08)											
											HEART (24)											
											LUNGS (25)											
											OTHER (19)											
											MULT. BODY PARTS (20)											
											TOTAL BODY (00)											
10	9	8	7	6	5	4	3	2	1	0	0	1	2	3	4	5	6	7	8	9	10	
# OF SURVIVORS - 179											# OF SURVIVORS - 941											

**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

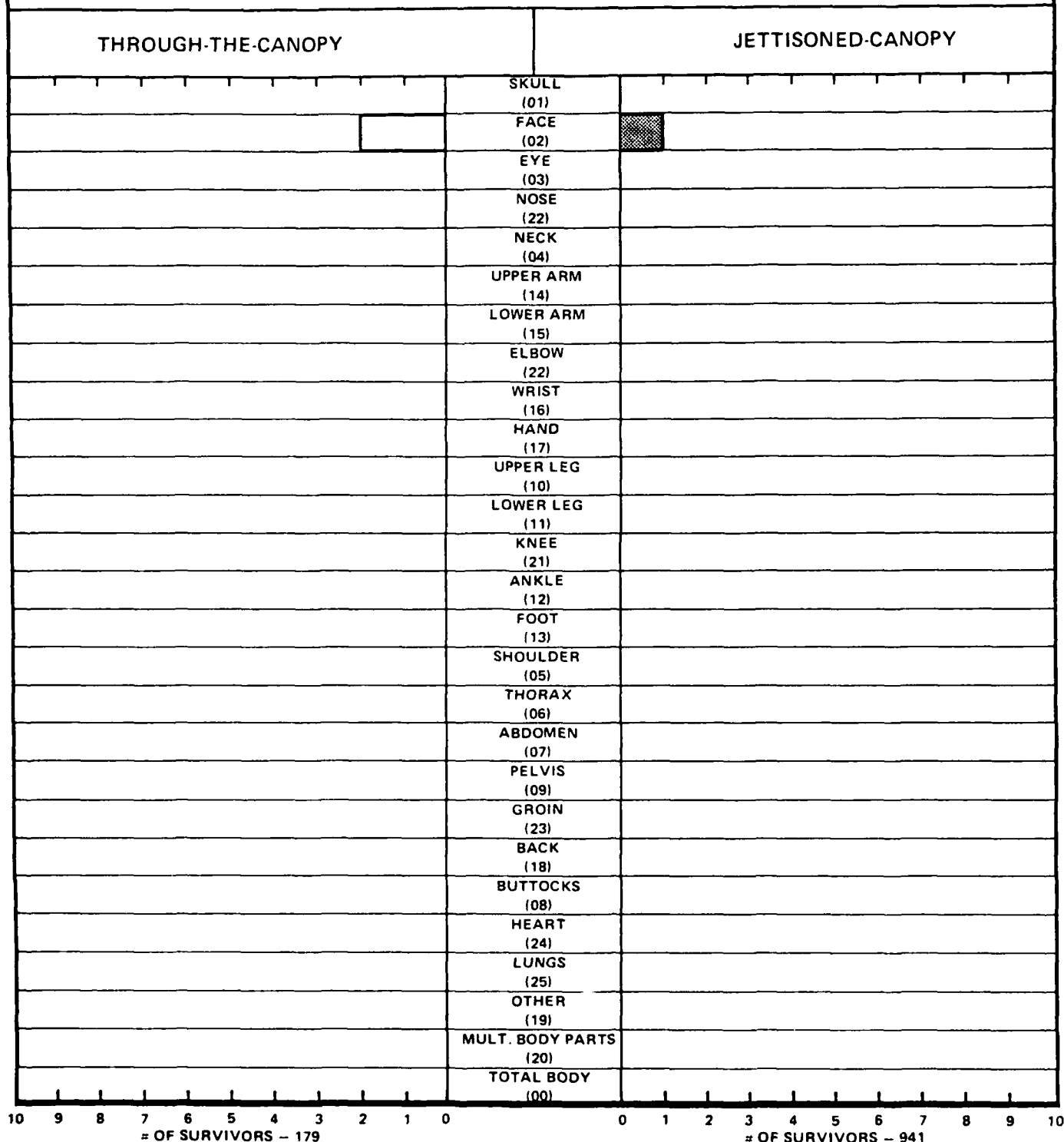
INJURY DIAGNOSIS: BITE (SURVIVORS ONLY)



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS: ACOUSTIC TRAUMA



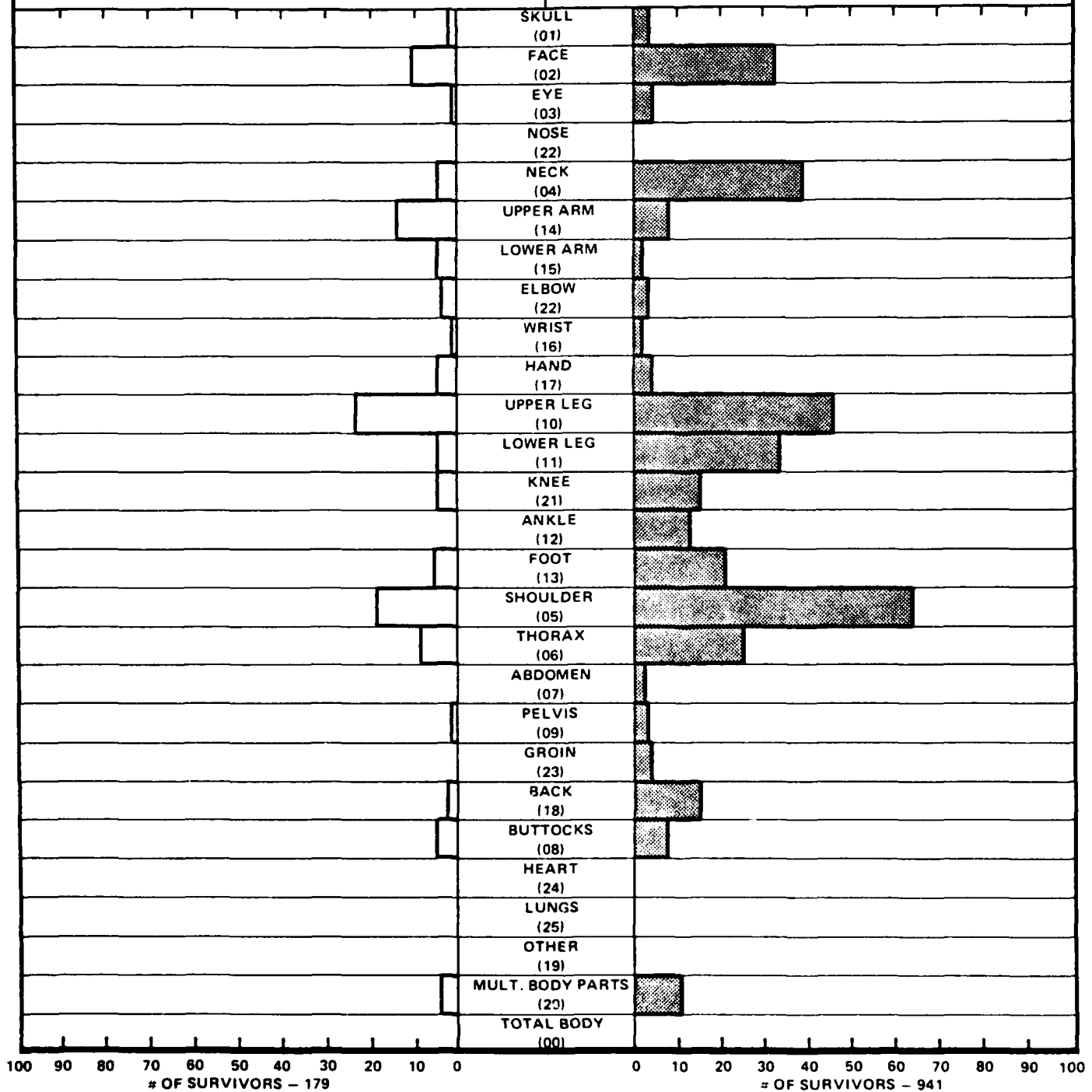
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: CONTUSION

THROUGH-THE-CANOPY

JETTISONED-CANOPY

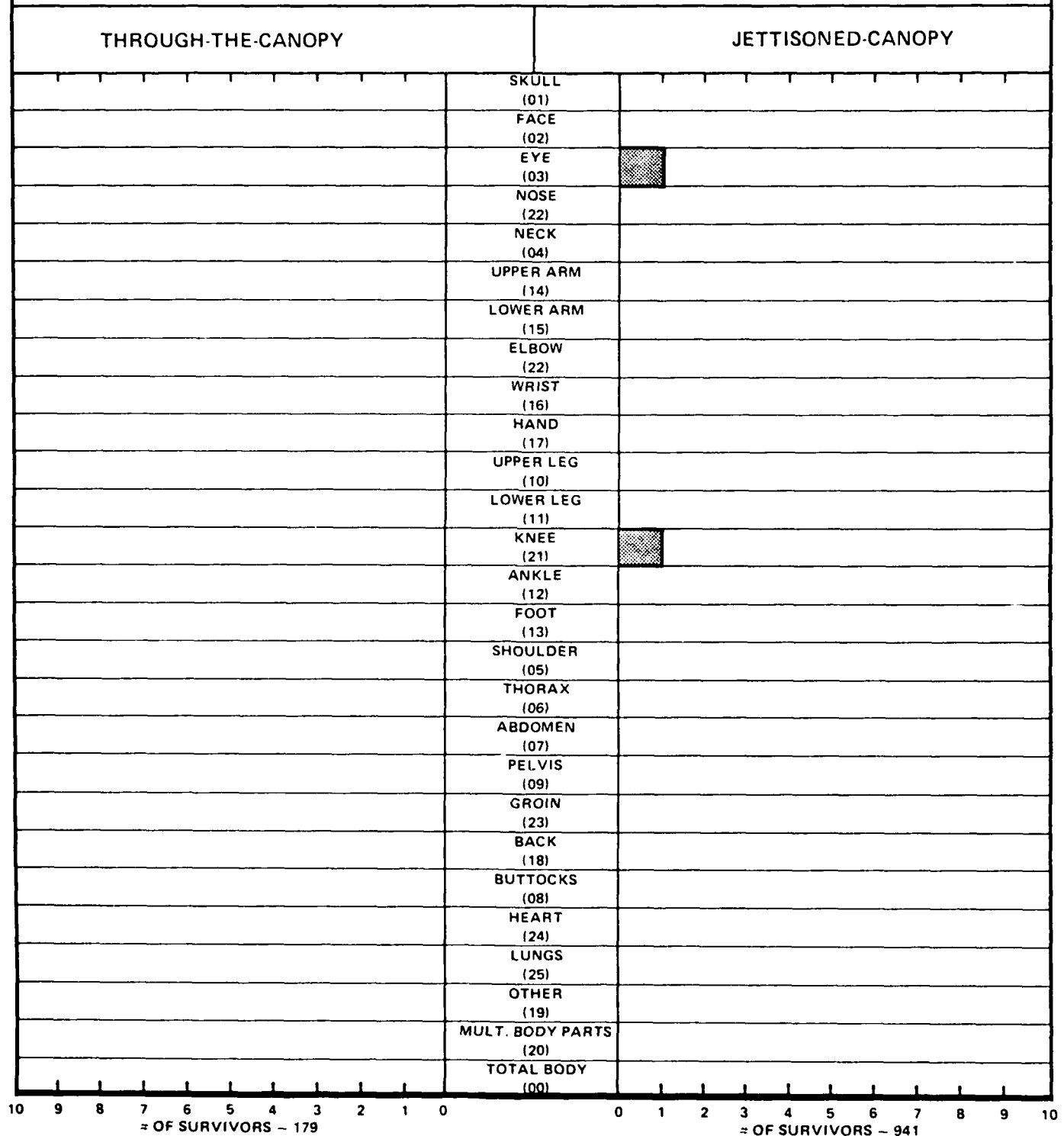


JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

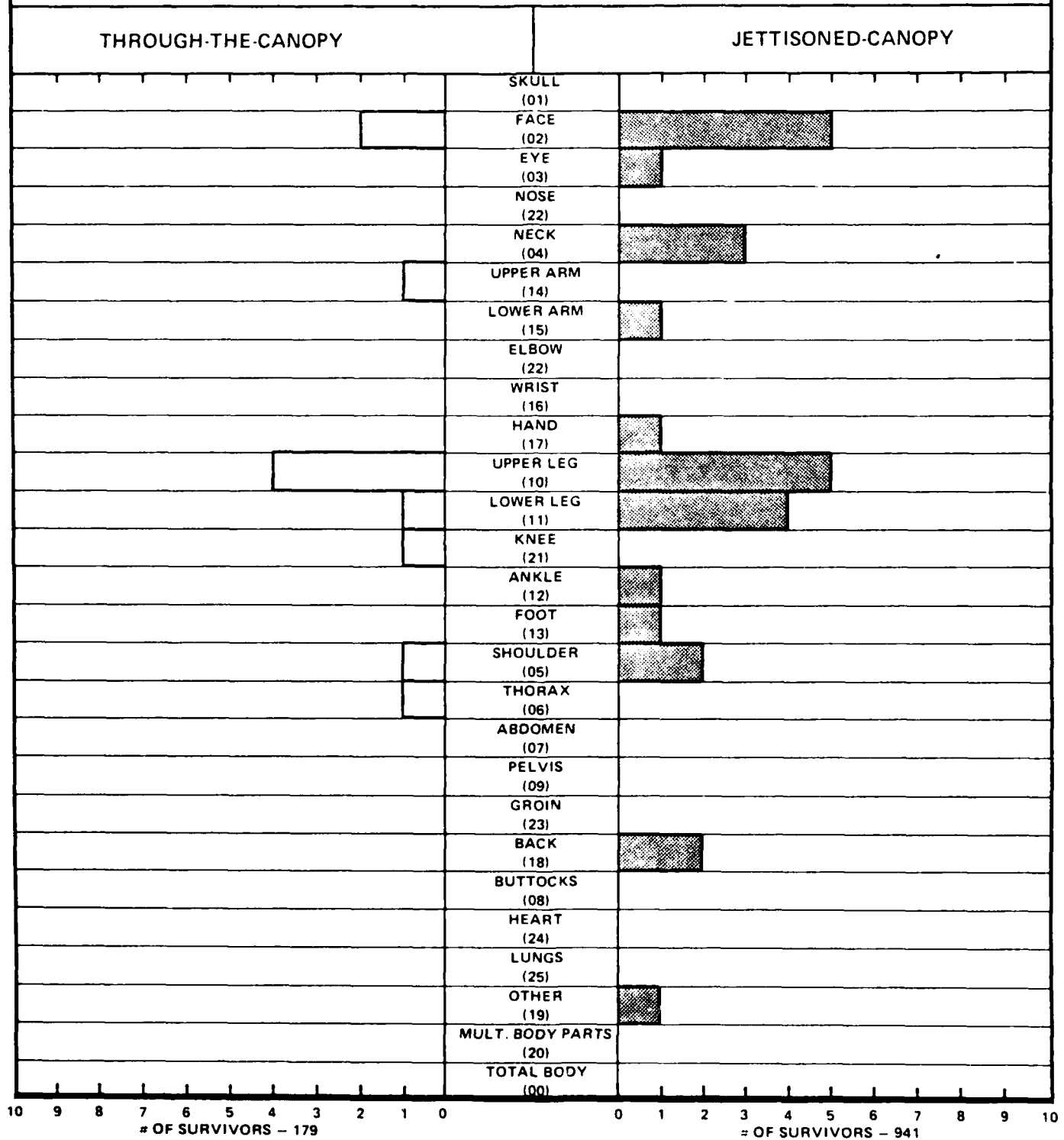
INJURY DIAGNOSIS: EDEMA



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

INJURY DIAGNOSIS: HEMATOMA

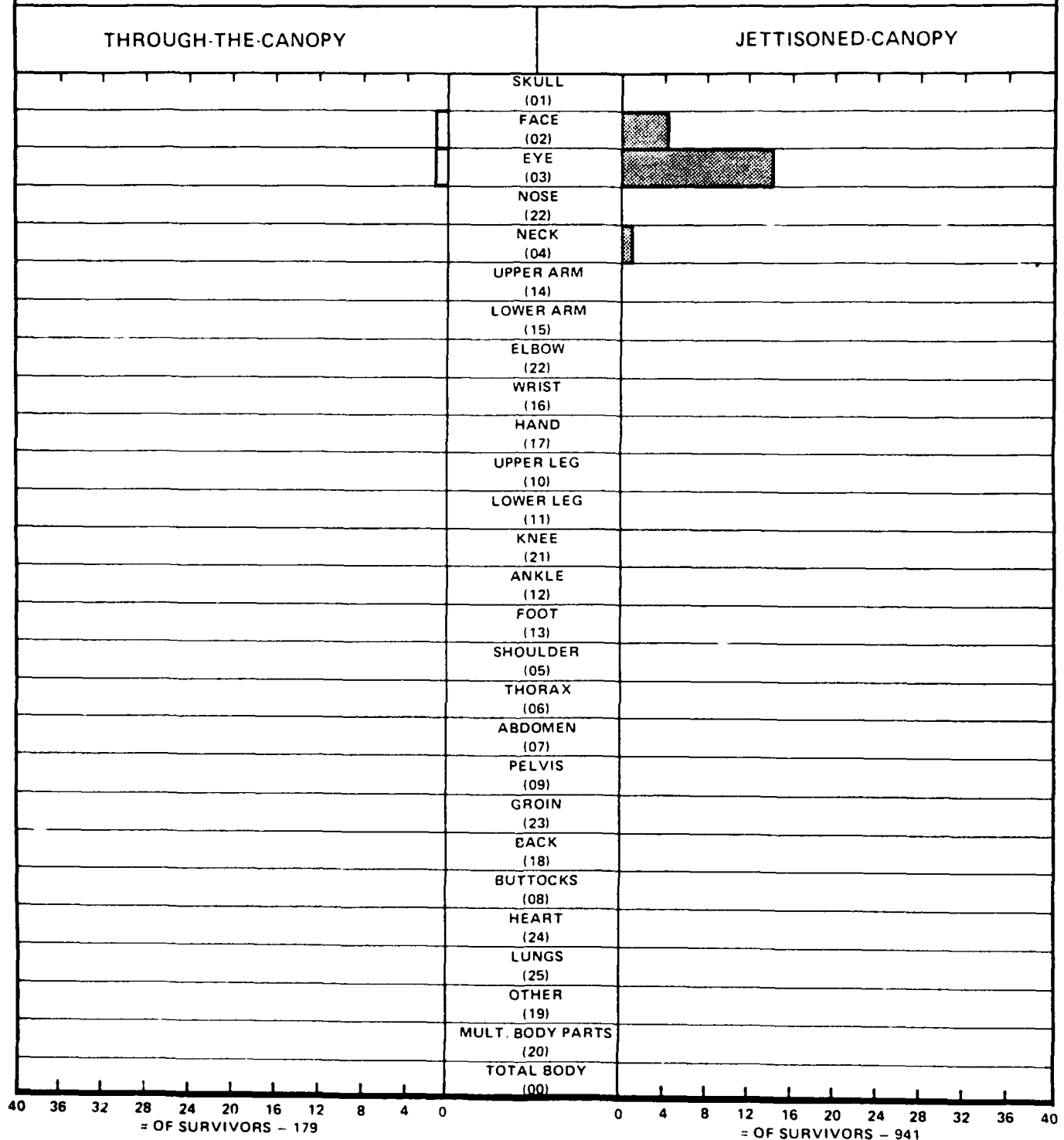


JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

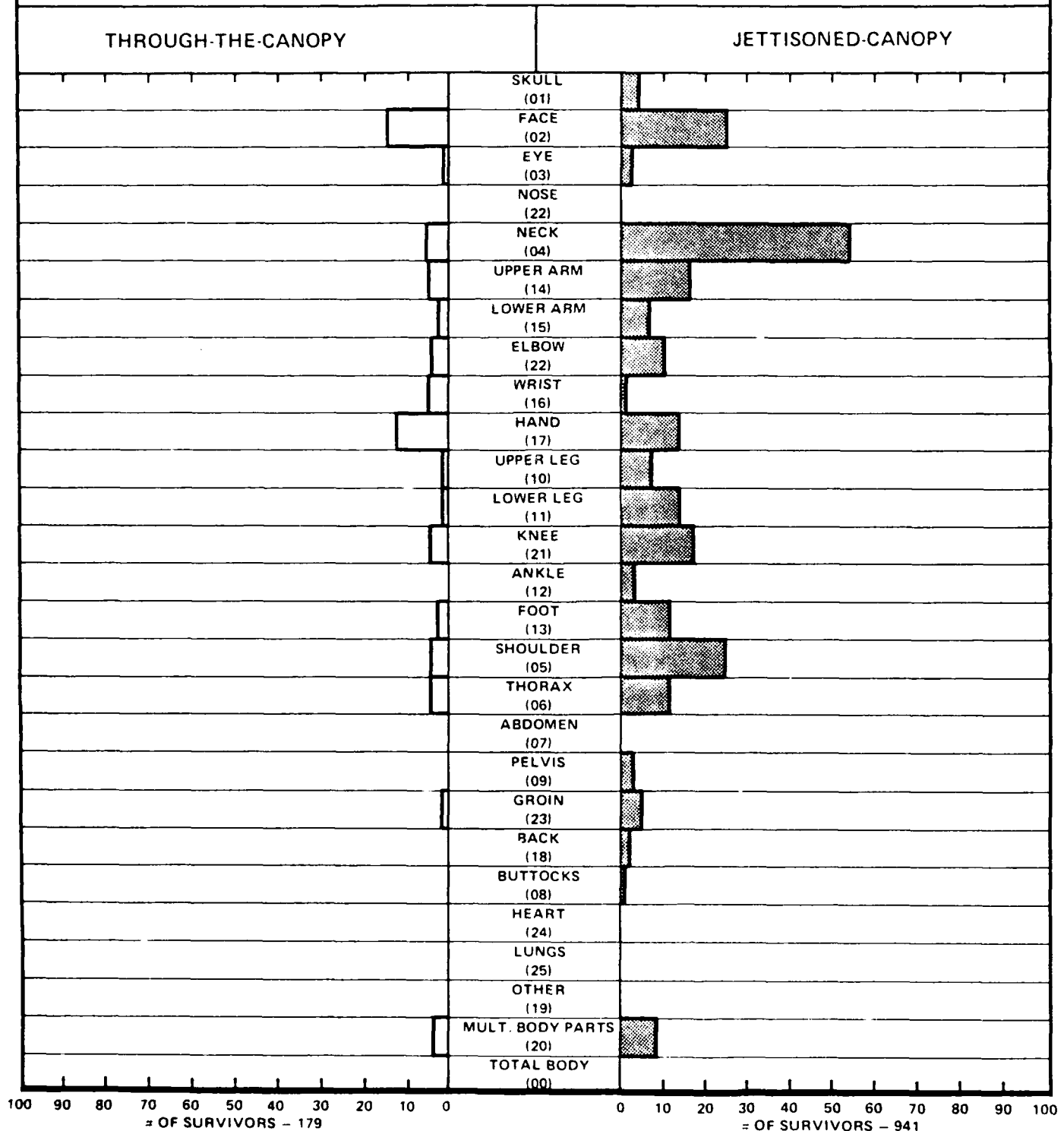
INJURY DIAGNOSIS: HEMORRHAGE



COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

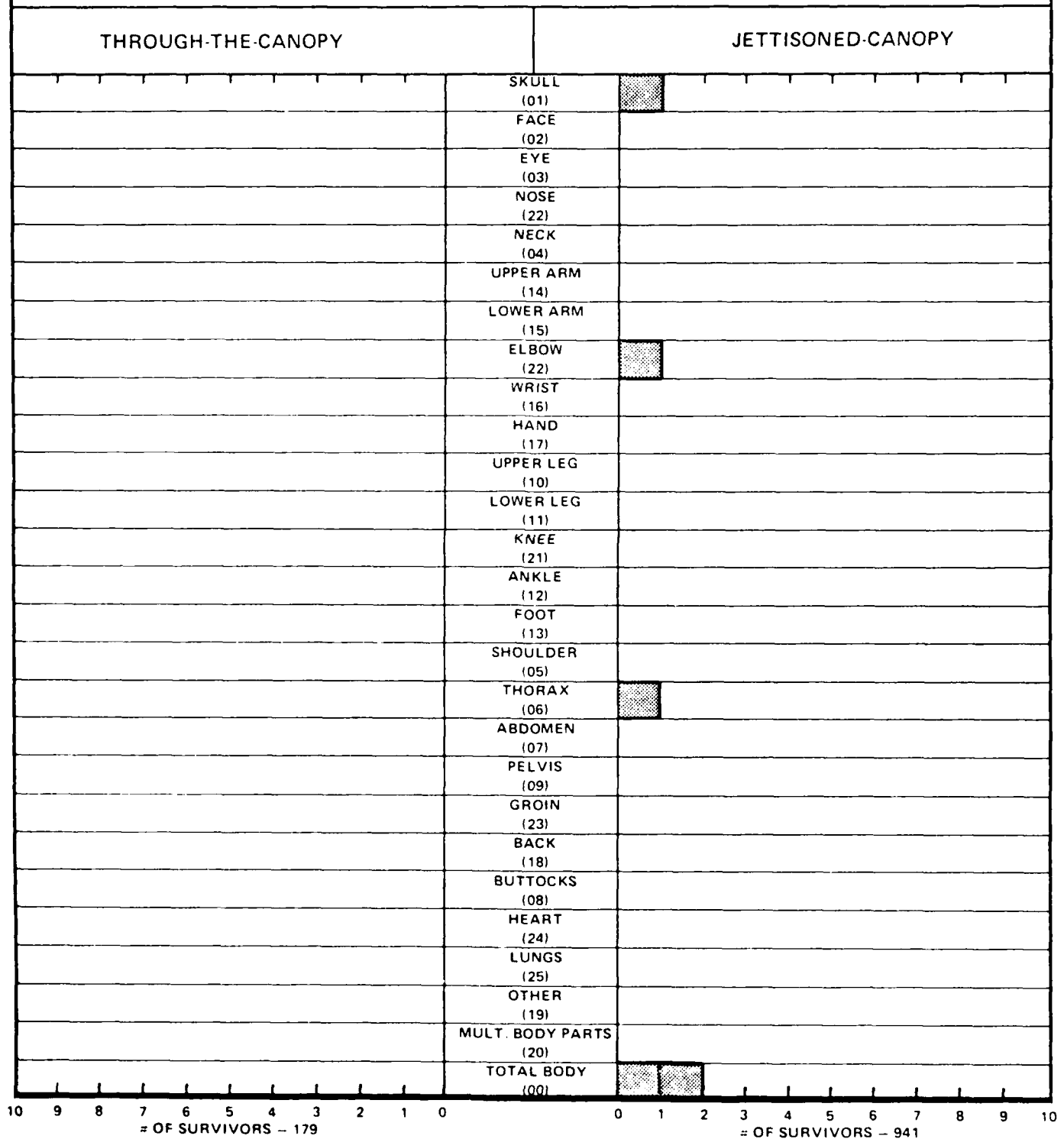
INJURY DIAGNOSIS: ABRASION



**COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

(SURVIVORS ONLY)

INJURY DIAGNOSIS - UNKNOWN/OTHER



[illegible]

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY BODY PART INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

(SURVIVORS ONLY)

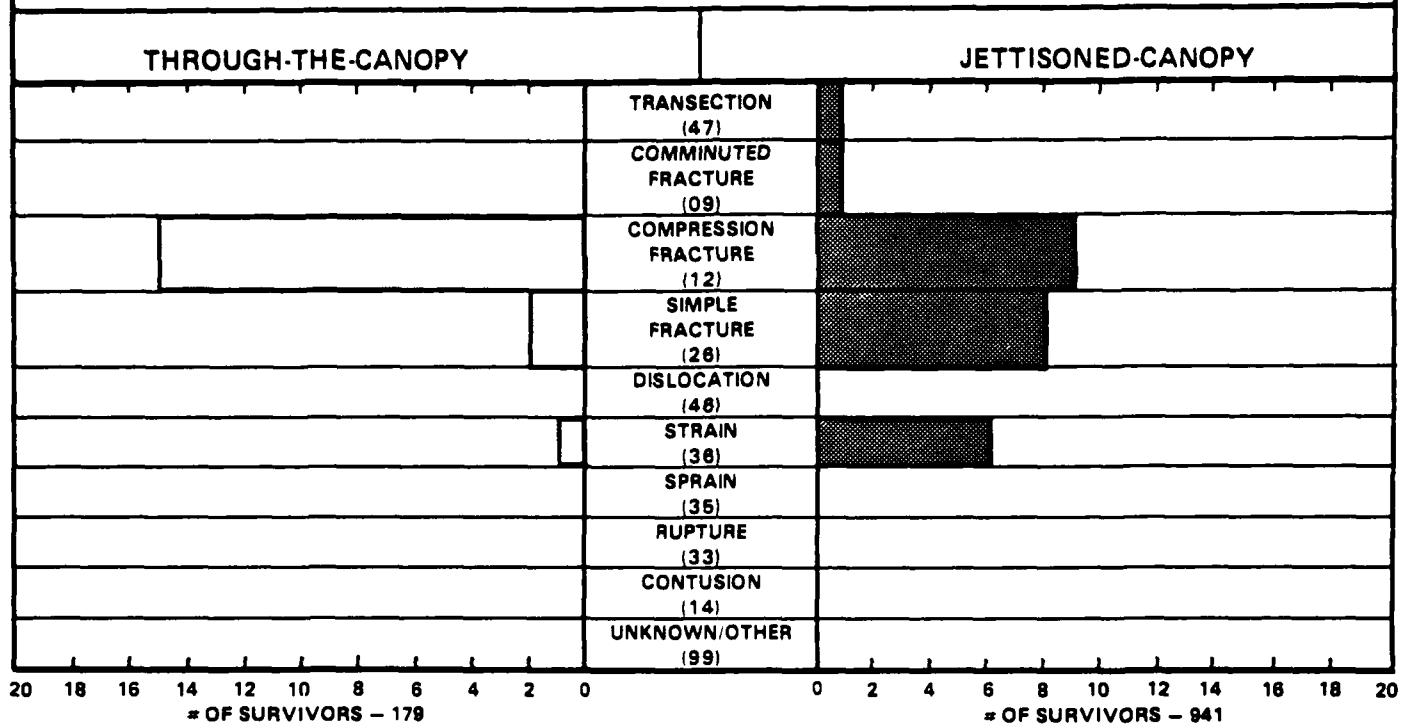
INJURY DIAGNOSIS: CODE NOT IN SAFCEN
MANUAL

THROUGH-THE-CANOPY											JETTISONED-CANOPY										
											SKULL (01)										
											FACE (02)										
											EYE (03)										
											NOSE (22)										
											NECK (04)										
											UPPER ARM (14)										
											LOWER ARM (15)										
											ELBOW (22)										
											WRIST (16)										
											HAND (17)										
											UPPER LEG (10)										
											LOWER LEG (11)										
											KNEE (21)										
											ANKLE (12)										
											FOOT (13)										
											SHOULDER (05)										
											THORAX (06)										
											ABDOMEN (07)										
											PELVIS (09)										
											GROIN (23)										
											BACK (18)										
											BUTTOCKS (08)										
											HEART (24)										
											LUNGS (25)										
											OTHER (19)										
											MULT BODY PARTS (20)										
											TOTAL BODY (00)										
10	9	8	7	6	5	4	3	2	1	0	0	1	2	3	4	5	6	7	8	9	10
# OF SURVIVORS -- 179											# OF SURVIVORS -- 941										

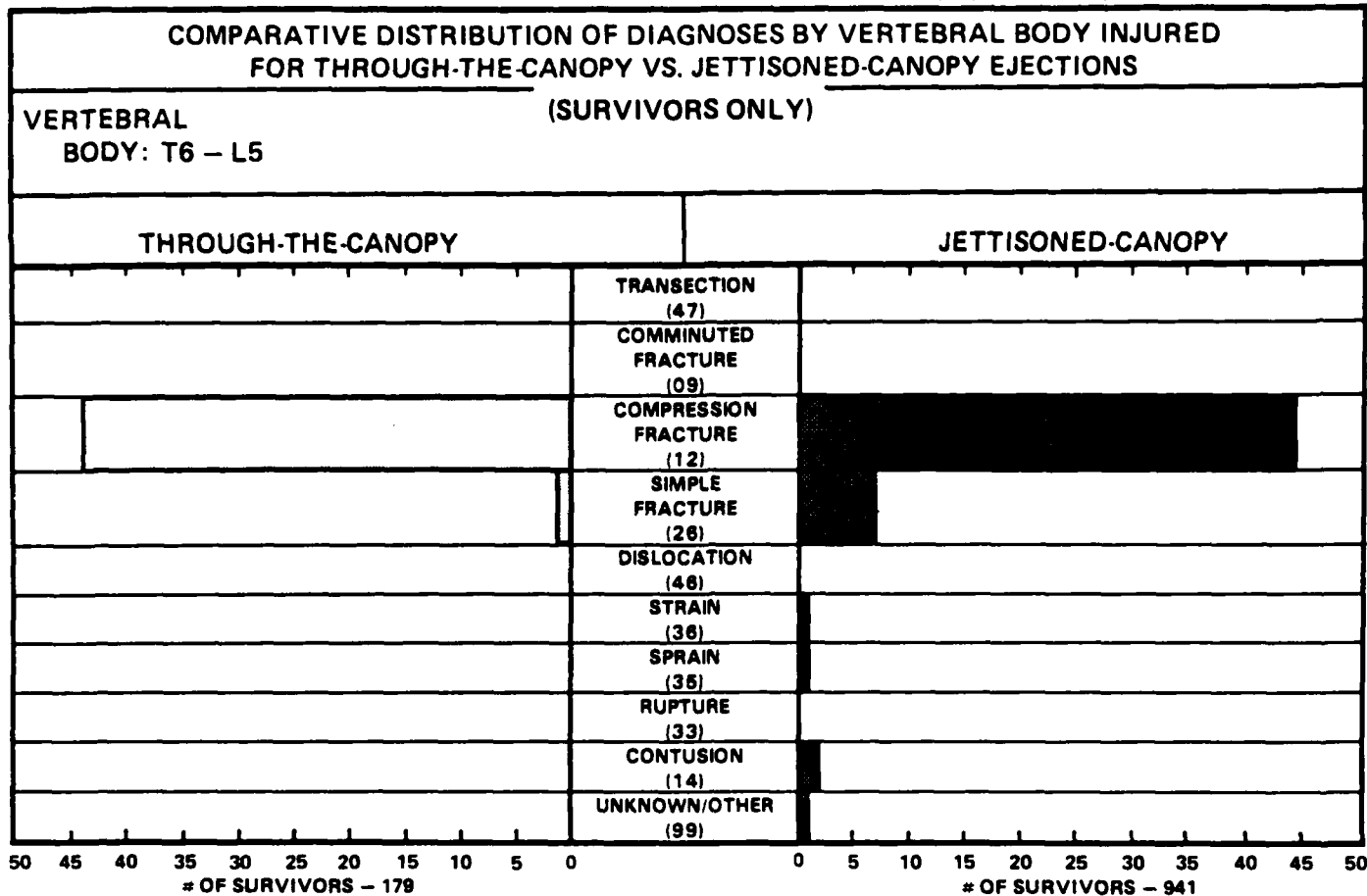
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

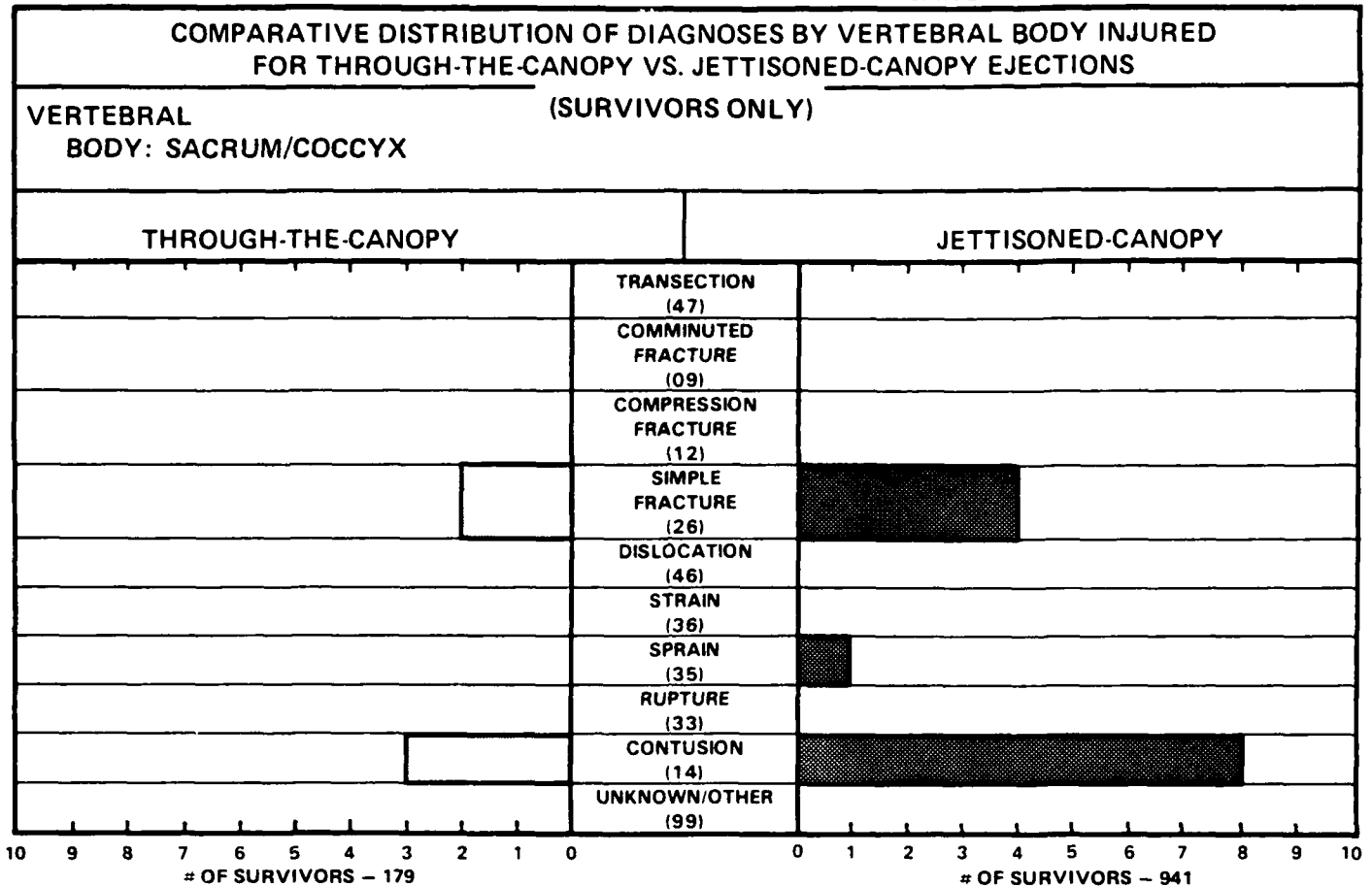
VERTEBRAL BODY: C1 - T5 (SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 – DECEMBER 1979

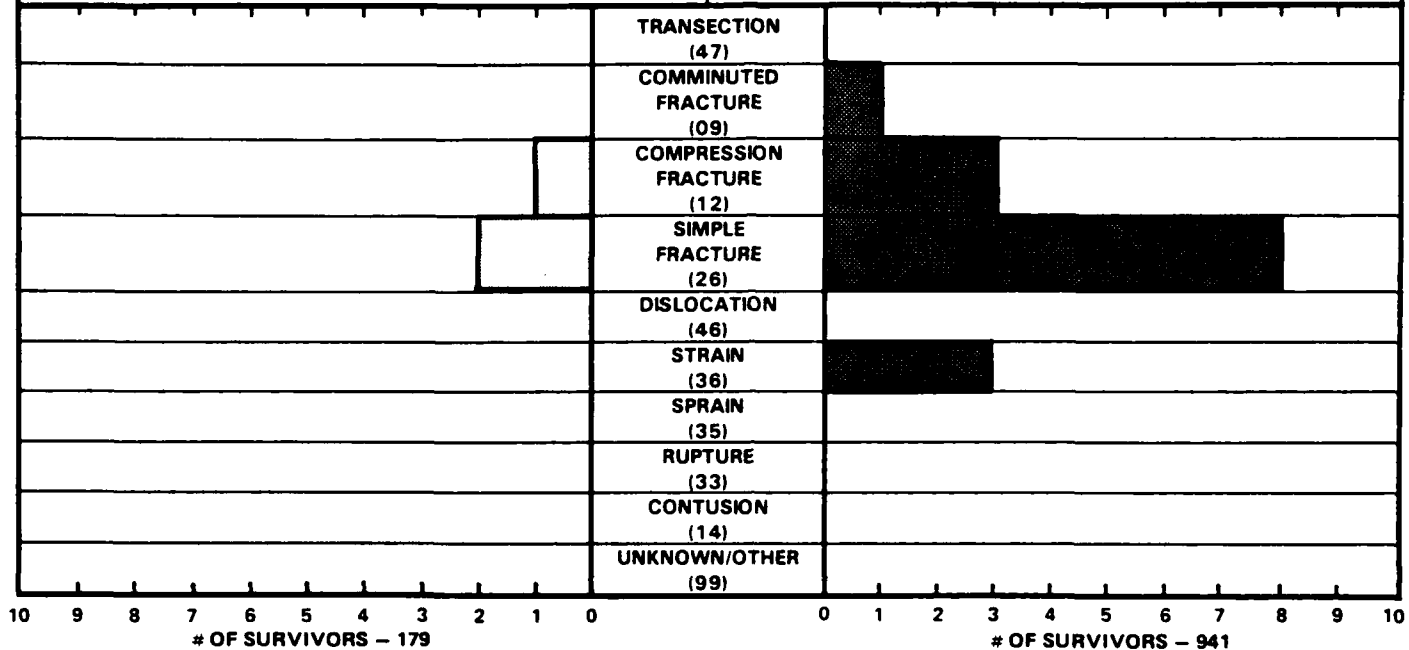
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: C1 – C7

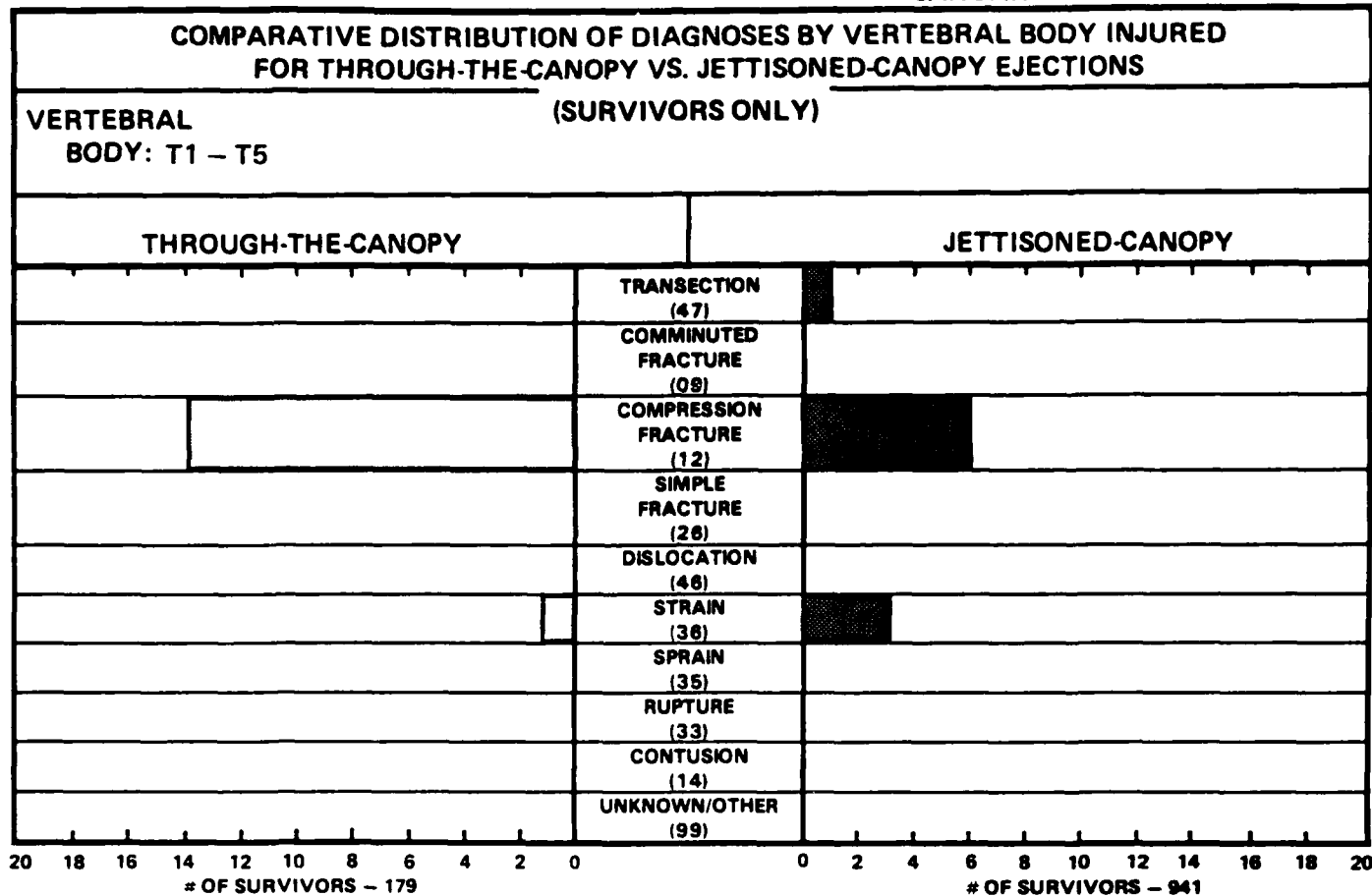
(SURVIVORS ONLY)

THROUGH-THE-CANOPY

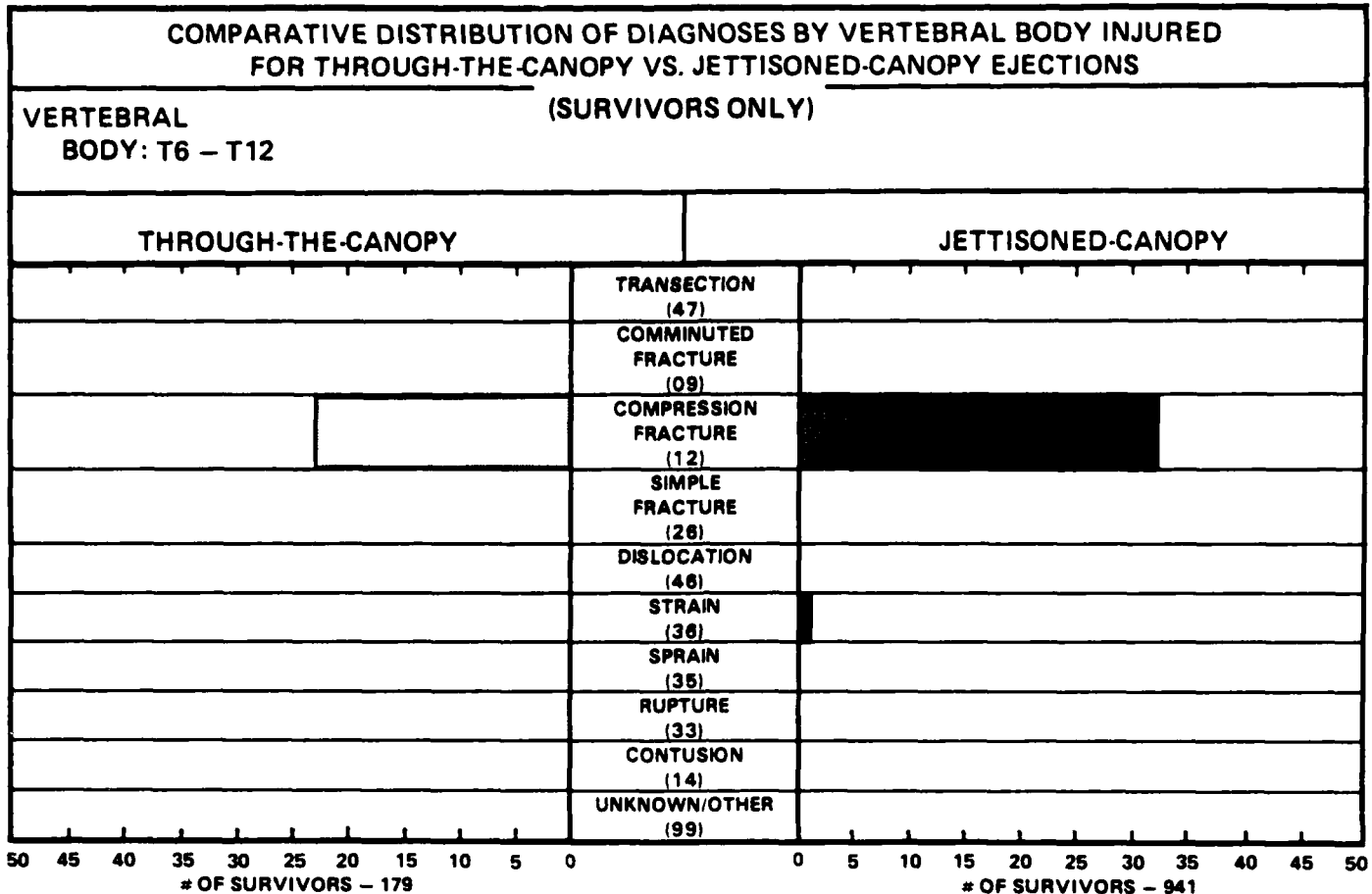
JETTISONED-CANOPY



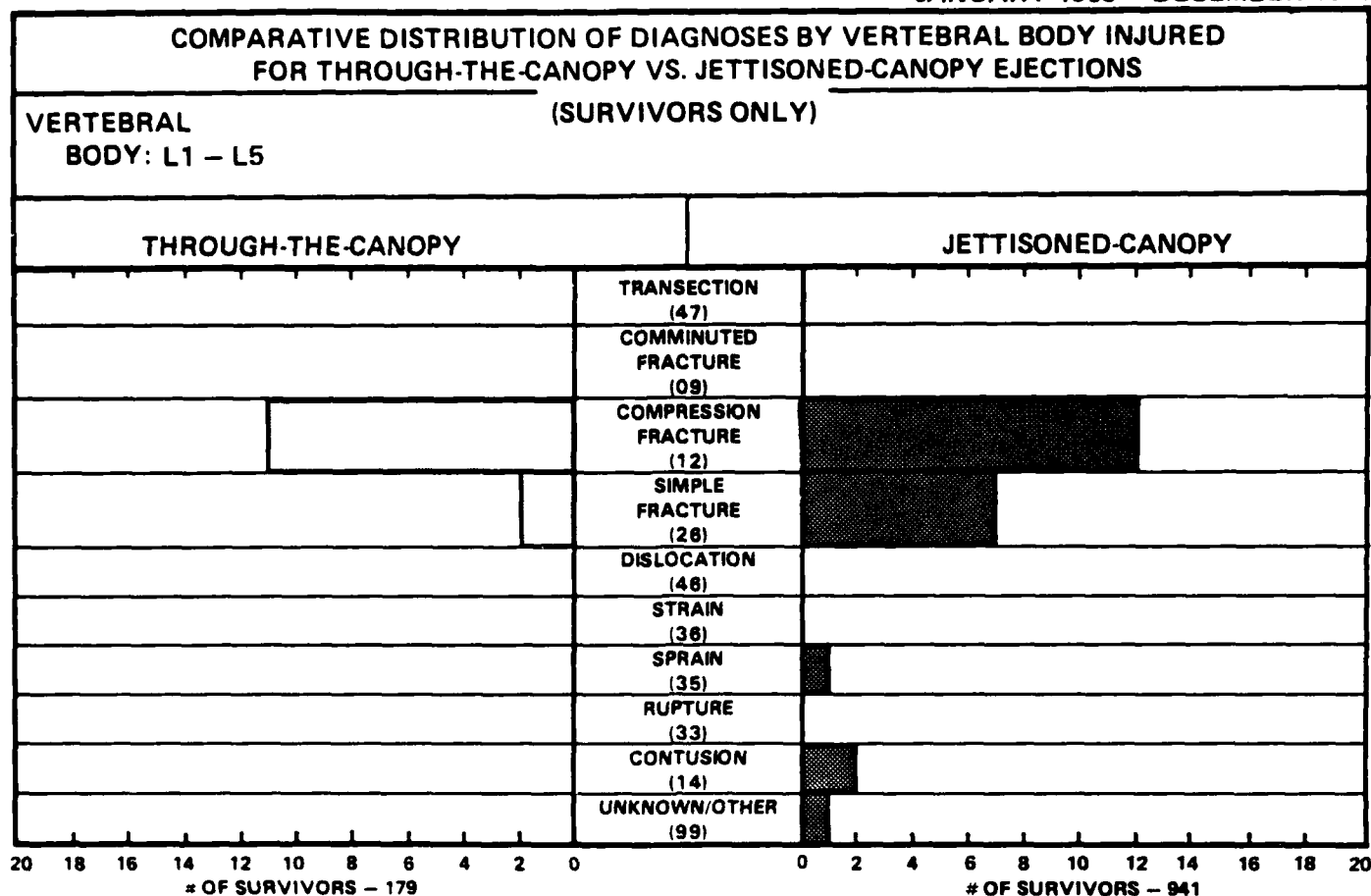
JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 – DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: C2

(SURVIVORS ONLY)

THROUGH-THE-CANOPY

JETTISONED-CANOPY

TRANSECTION
(47)

COMMUNUTED
FRACTURE
(09)

COMPRESSION
FRACTURE
(12)

SIMPLE
FRACTURE
(28)

DISLOCATION
(46)

STRAIN
(36)

SPRAIN
(35)

RUPTURE
(33)

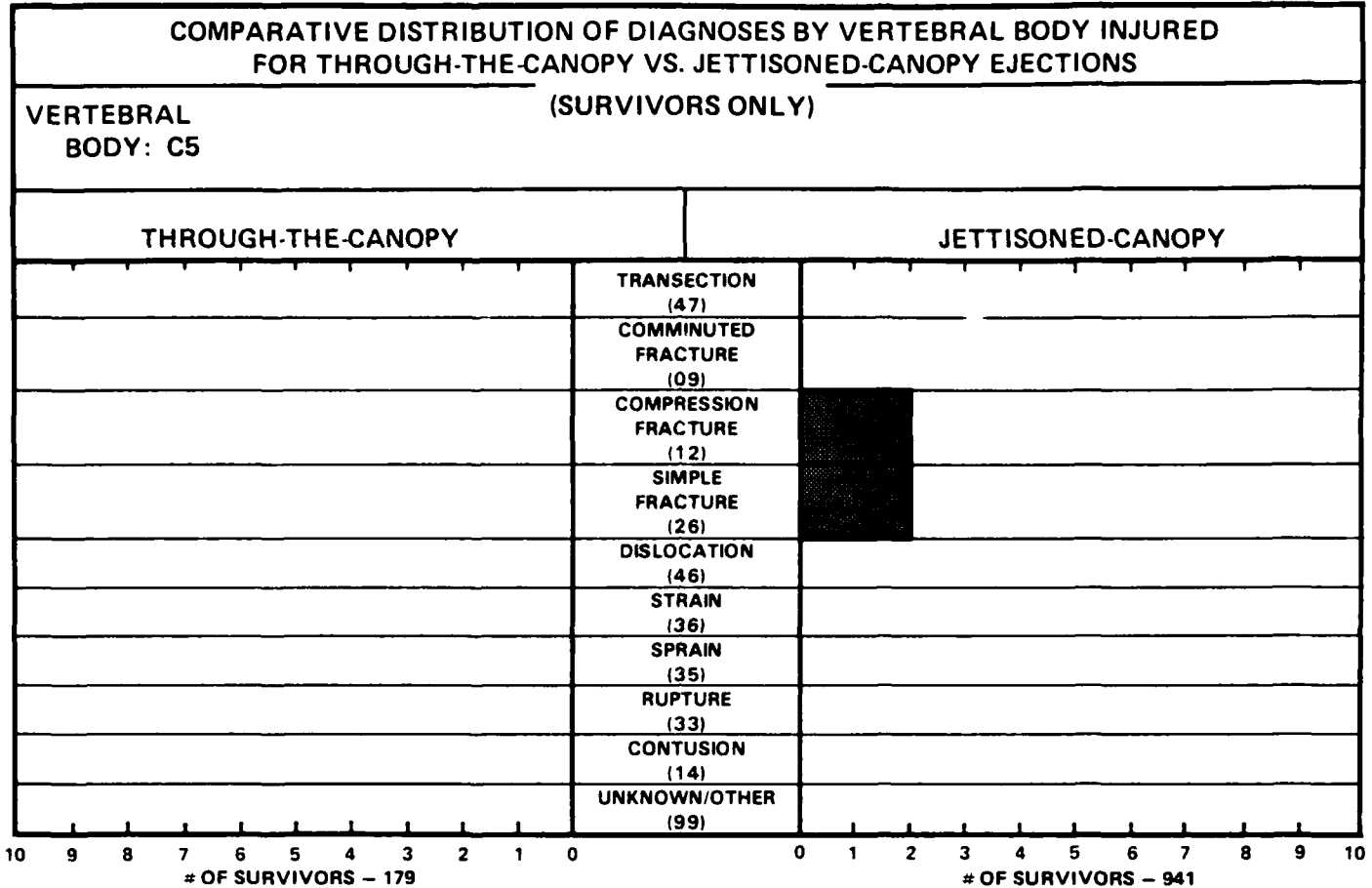
CONTUSION
(14)

UNKNOWN/OTHER
(99)

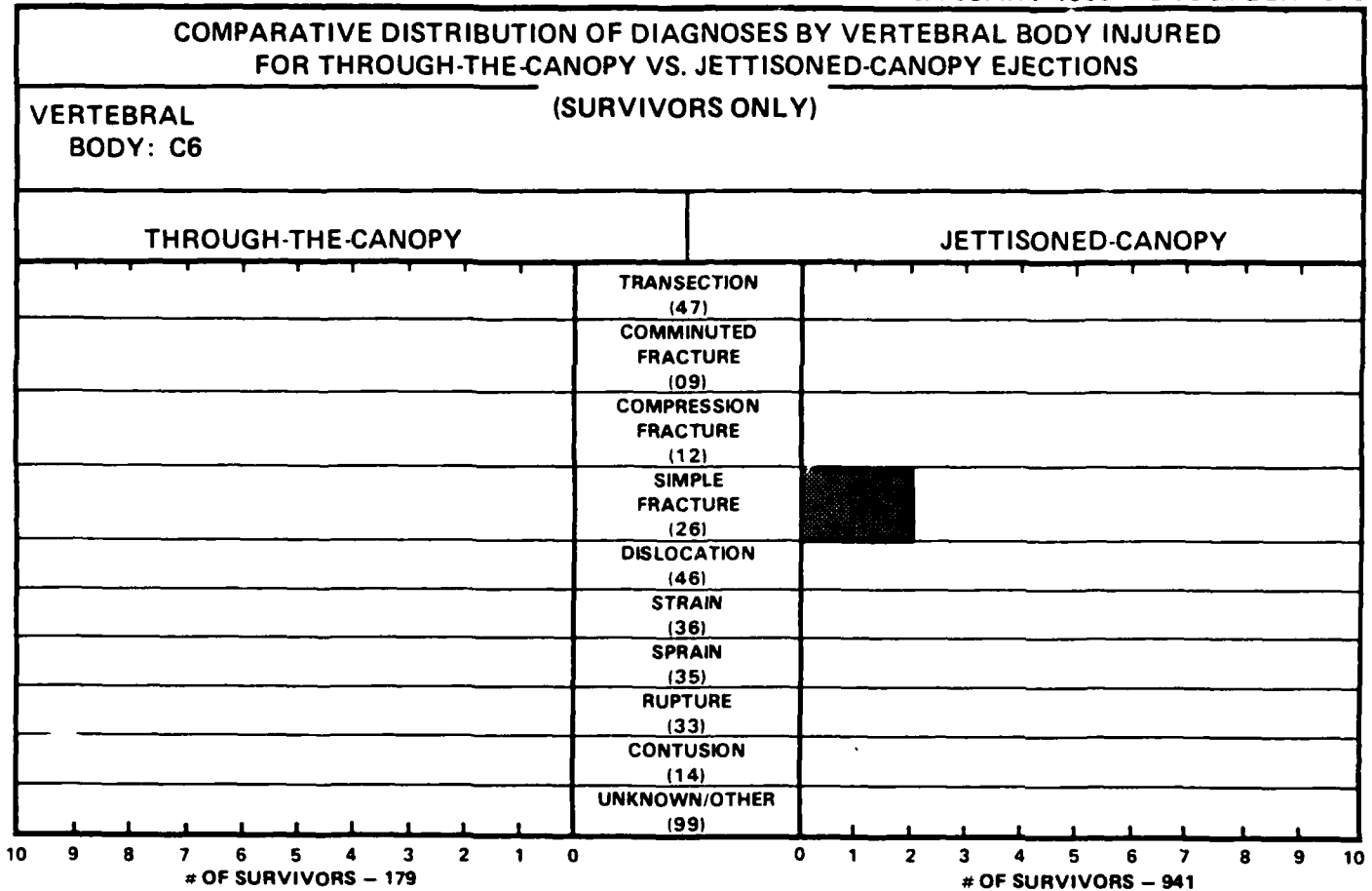
10 9 8 7 6 5 4 3 2 1 0
OF SURVIVORS – 179

0 1 2 3 4 5 6 7 8 9 10
OF SURVIVORS – 941

JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979

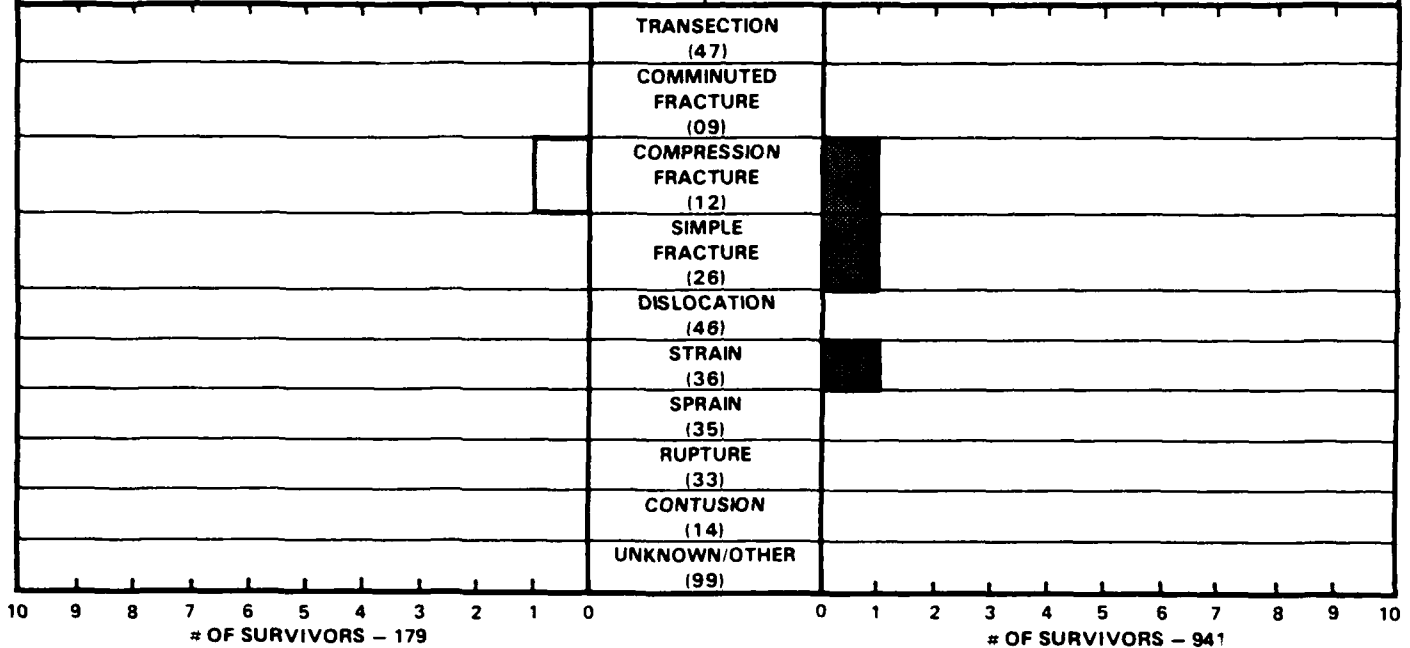
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: C7

(SURVIVORS ONLY)

THROUGH-THE-CANOPY

JETTISONED-CANOPY



JANUARY 1969 – DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T1

(SURVIVORS ONLY)

THROUGH-THE-CANOPY

JETTISONED-CANOPY

TRANSECTION
(47)

COMMUNUTED
FRACTURE
(09)

COMPRESSION
FRACTURE
(12)

SIMPLE
FRACTURE
(26)

DISLOCATION
(46)

STRAIN
(36)

SPRAIN
(35)

RUPTURE
(33)

CONTUSION
(14)

UNKNOWN/OTHER
(99)

10 9 8 7 6 5 4 3 2 1 0
OF SURVIVORS – 179

0 1 2 3 4 5 6 7 8 9 10
OF SURVIVORS – 941

JANUARY 1969 - DECEMBER 1979

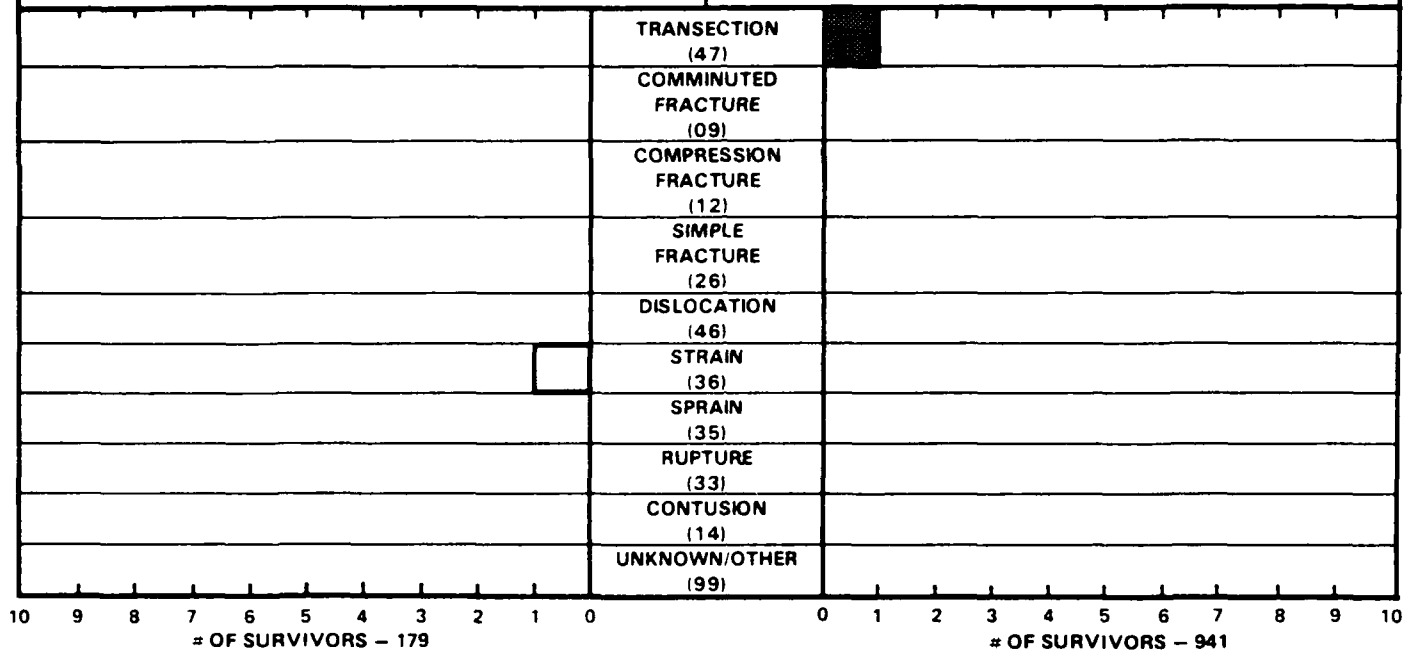
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T2

(SURVIVORS ONLY)

THROUGH-THE-CANOPY

JETTISONED-CANOPY



JANUARY 1969 - DECEMBER 1979

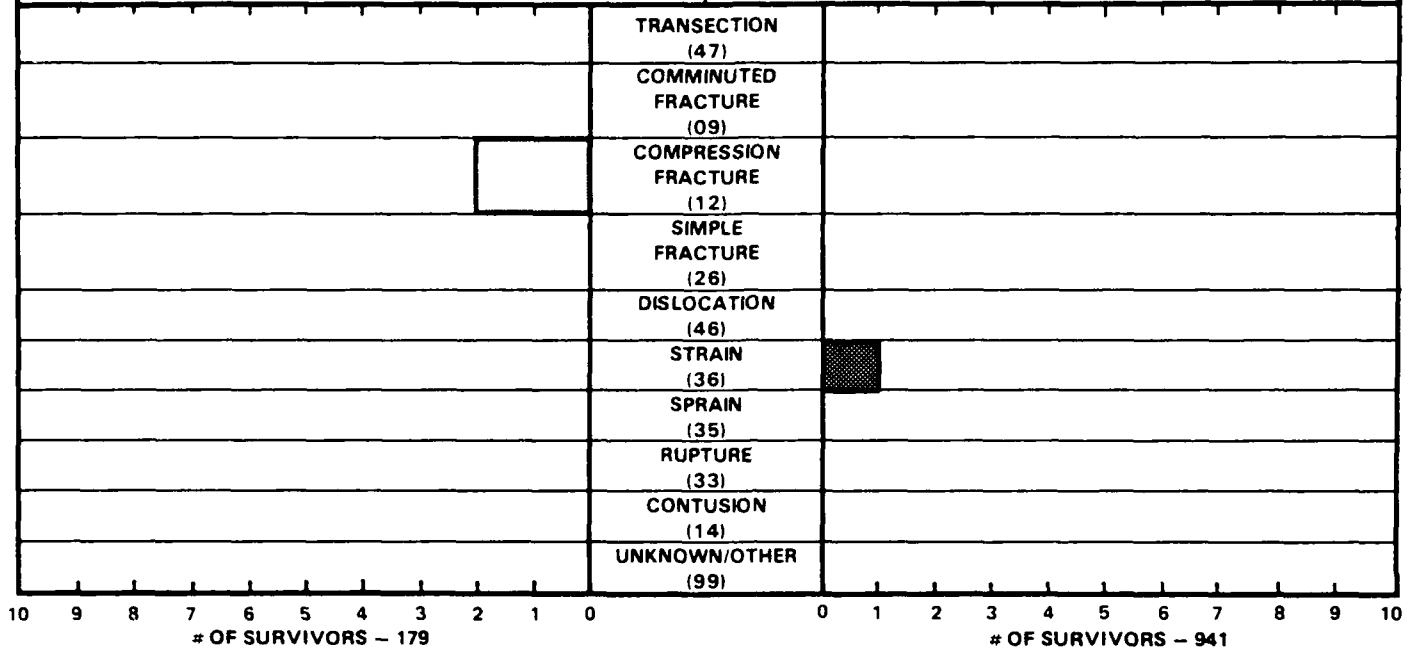
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T3

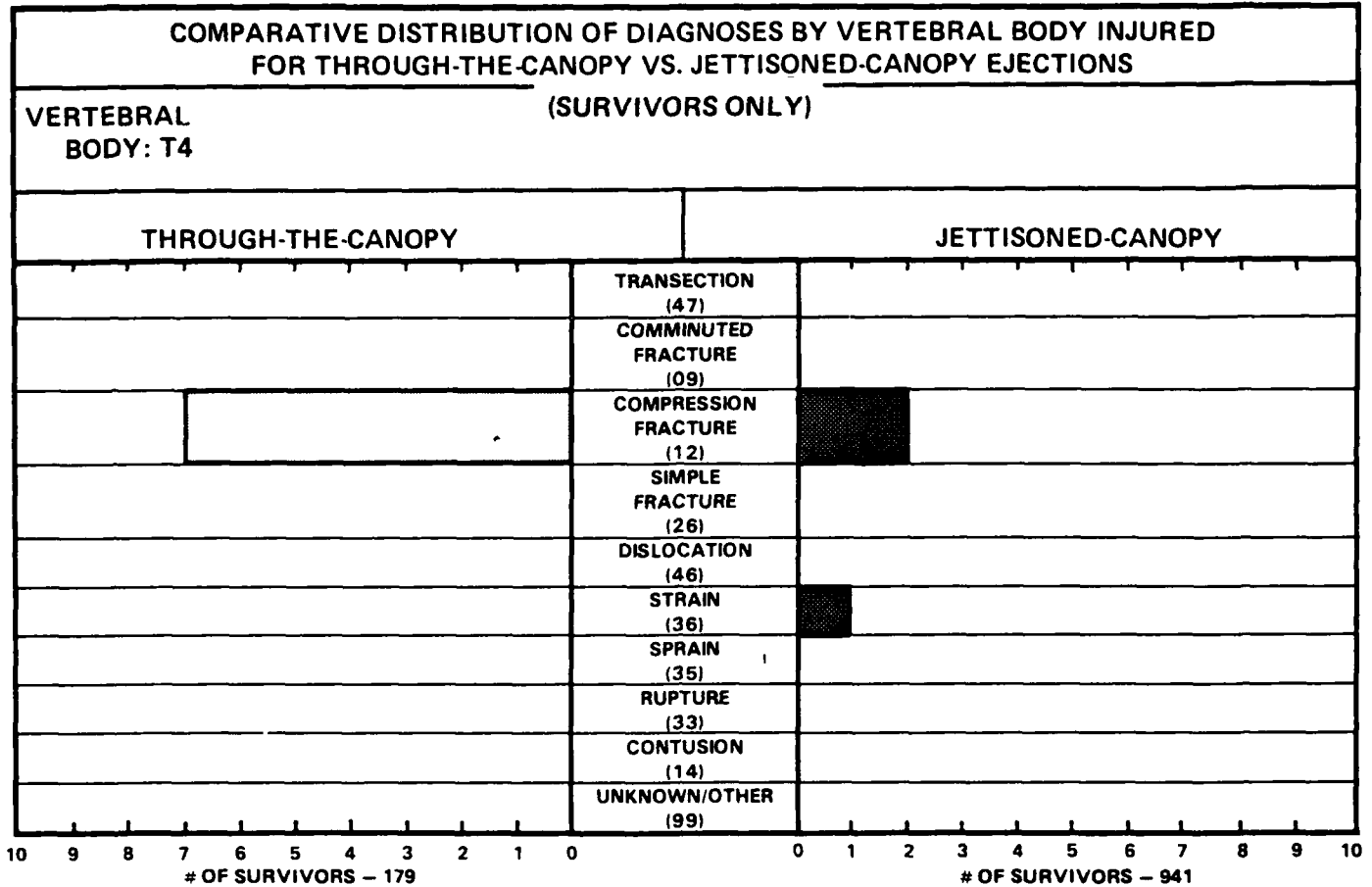
(SURVIVORS ONLY)

THROUGH-THE-CANOPY

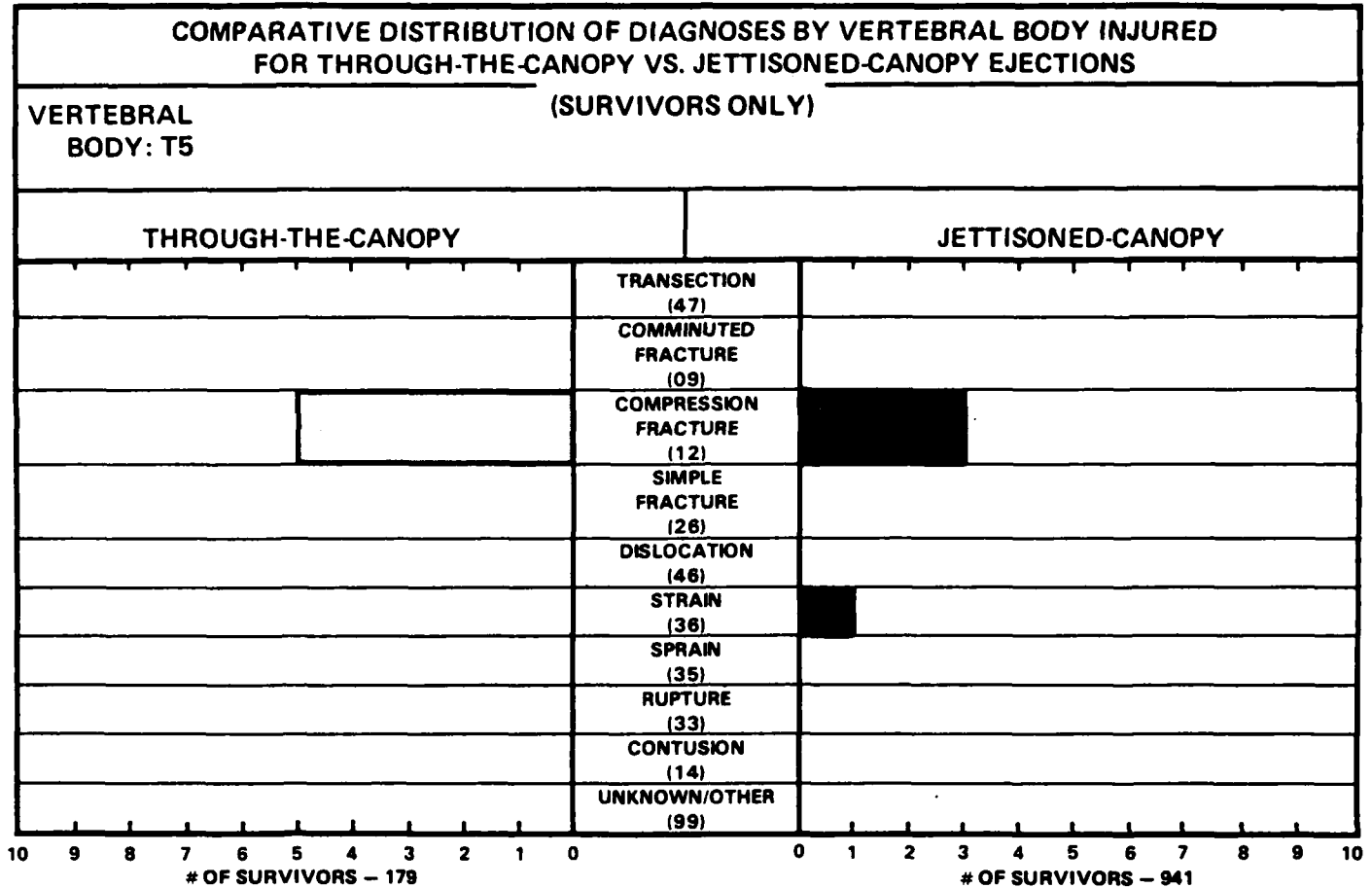
JETTISONED-CANOPY



JANUARY 1969 - DECEMBER 1979



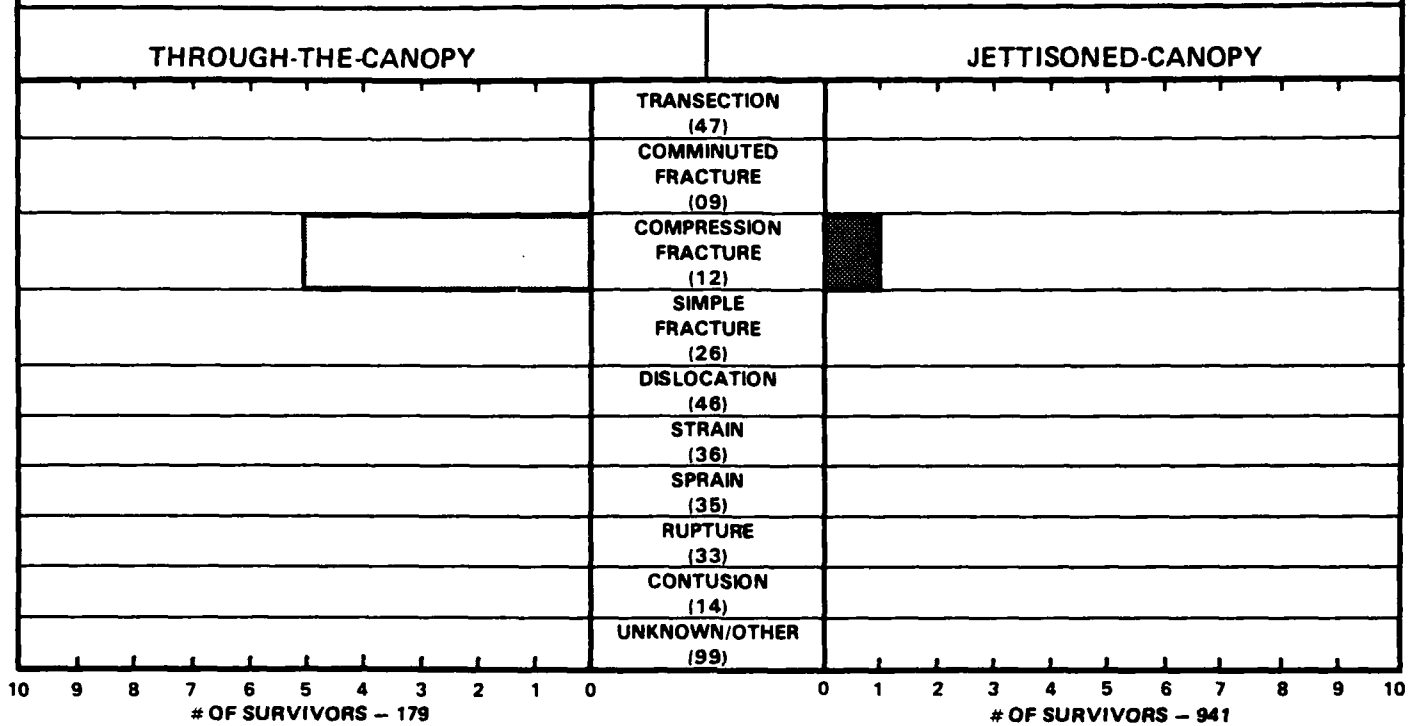
JANUARY 1969 – DECEMBER 1979



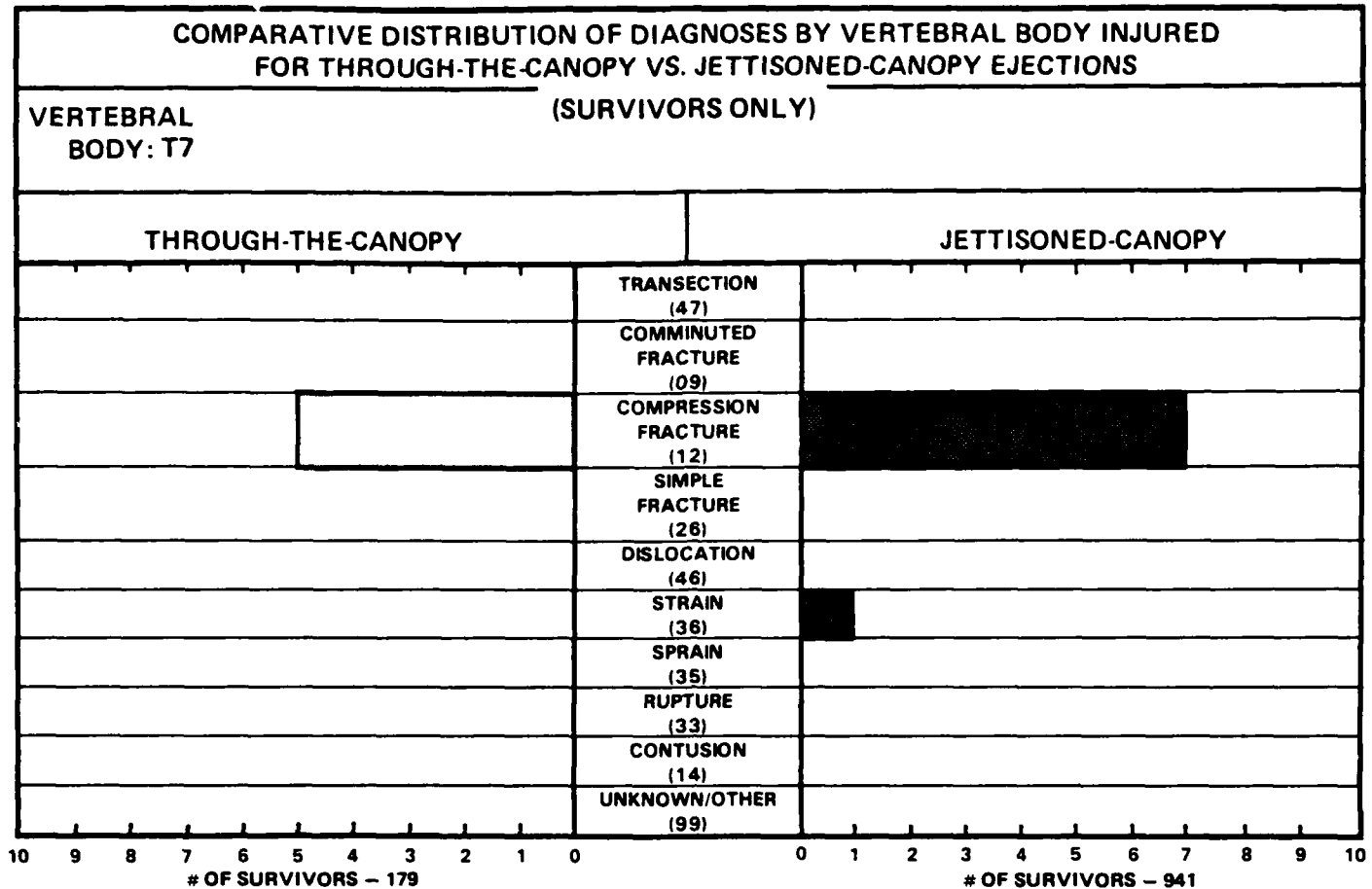
JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

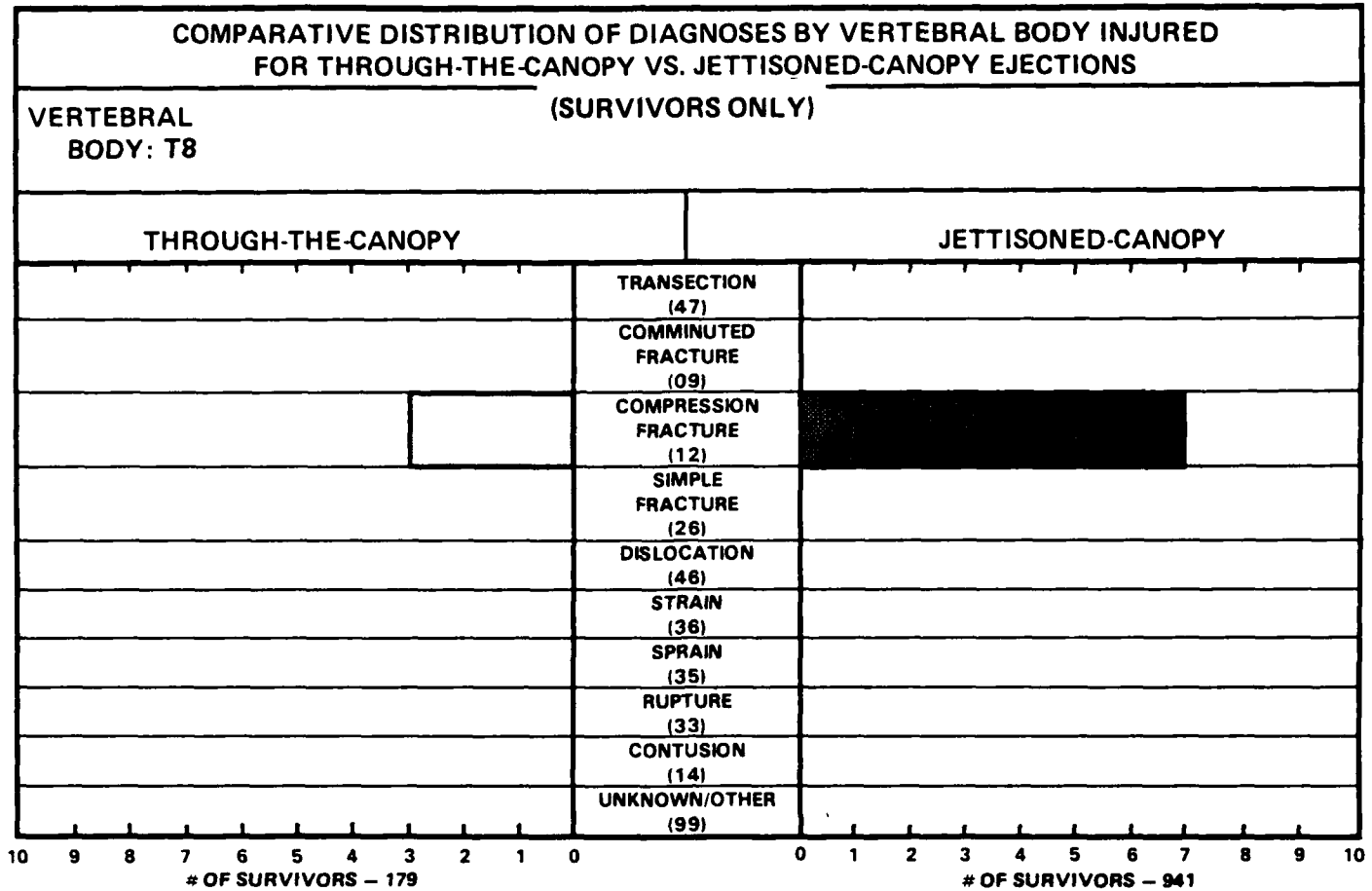
VERTEBRAL BODY: T6 (SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 – DECEMBER 1979



JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T9

(SURVIVORS ONLY)

THROUGH-THE-CANOPY

JETTISONED-CANOPY

TRANSECTION
(47)

COMMUNUTED
FRACTURE
(09)

COMPRESSION
FRACTURE
(12)

SIMPLE
FRACTURE
(26)

DISLOCATION
(46)

STRAIN
(36)

SPRAIN
(35)

RUPTURE
(33)

CONTUSION
(14)

UNKNOWN/OTHER
(99)

10 9 8 7 6 5 4 3 2 1 0
OF SURVIVORS - 179

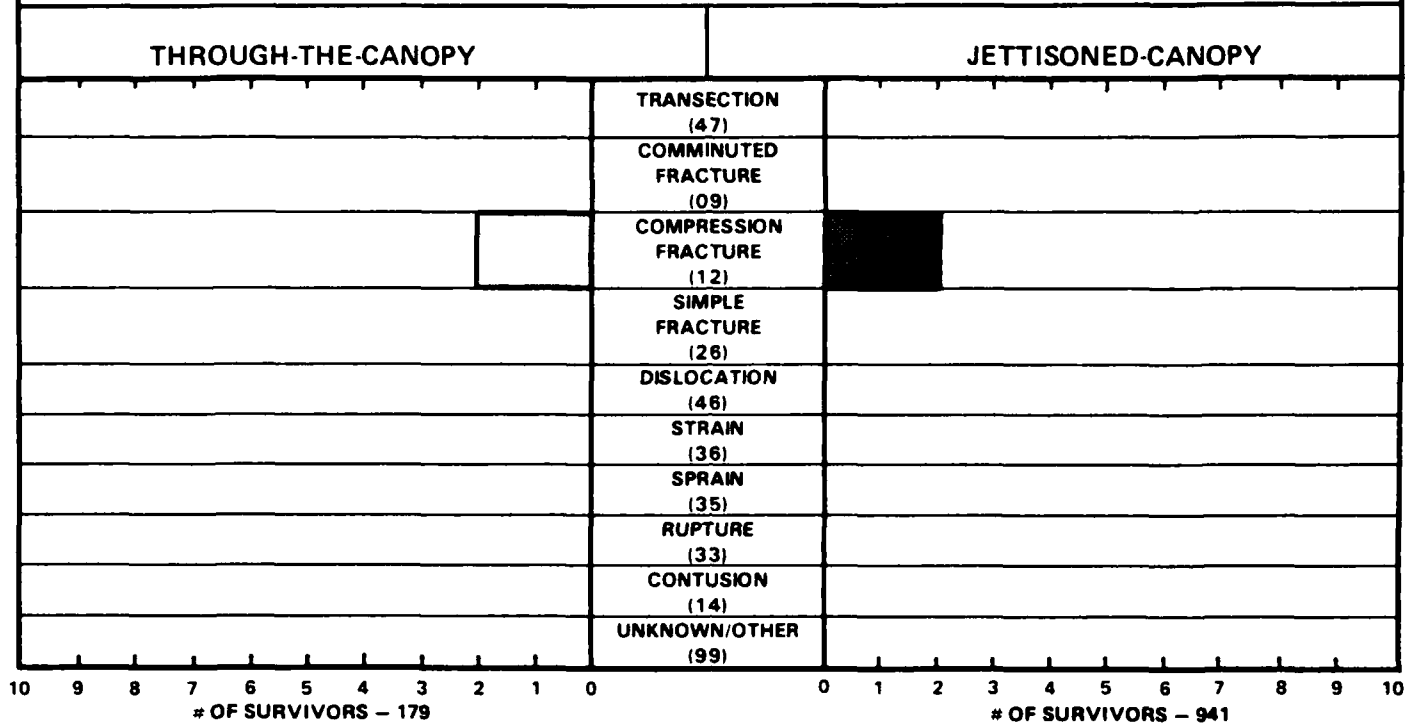
0 1 2 3 4 5 6 7 8 9 10
OF SURVIVORS - 941

JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T10

(SURVIVORS ONLY)

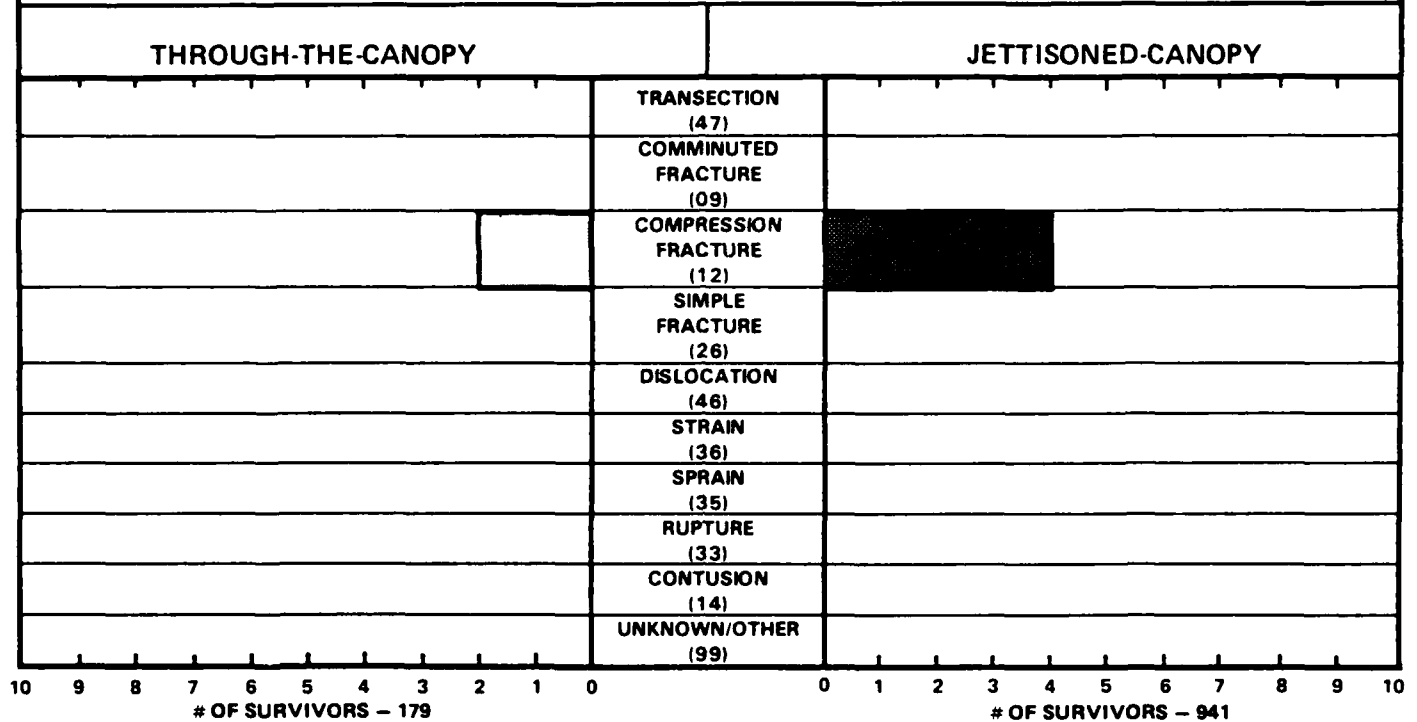


JANUARY 1969 - DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T11

(SURVIVORS ONLY)

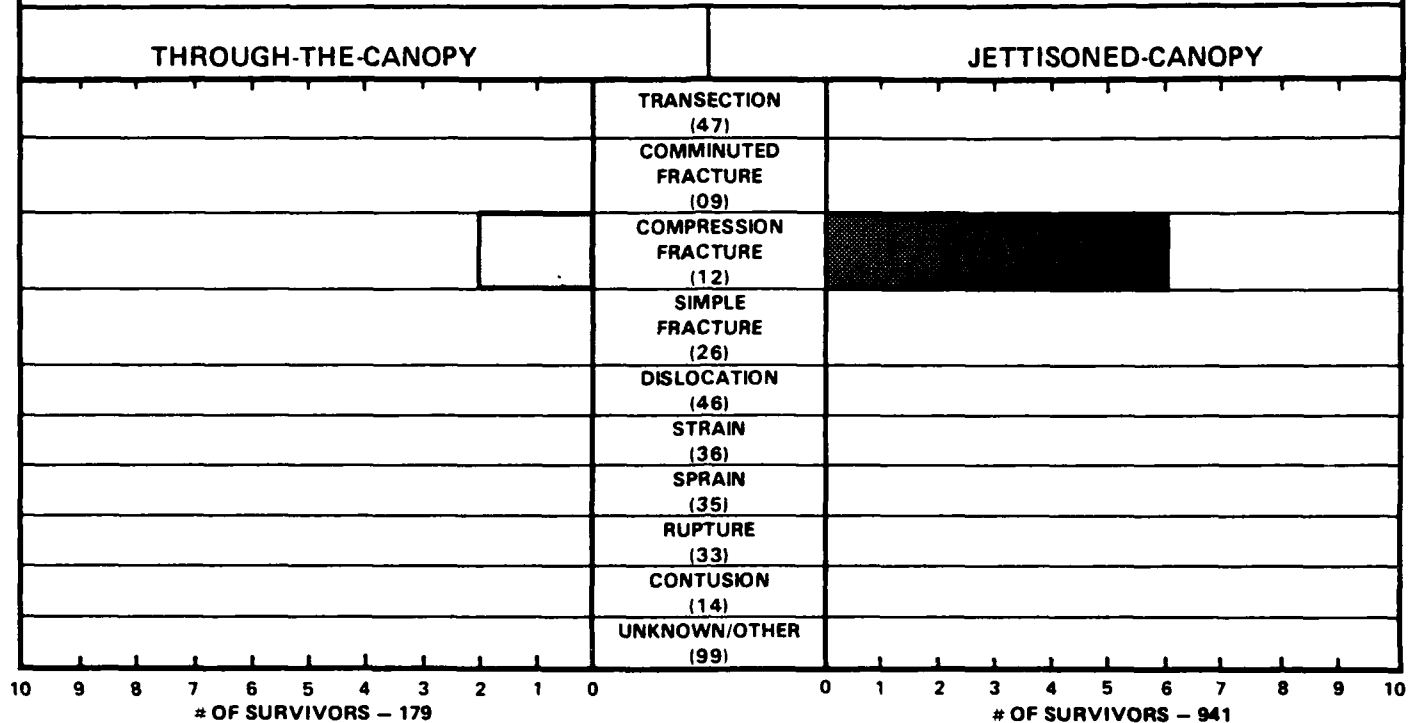


JANUARY 1969 – DECEMBER 1979

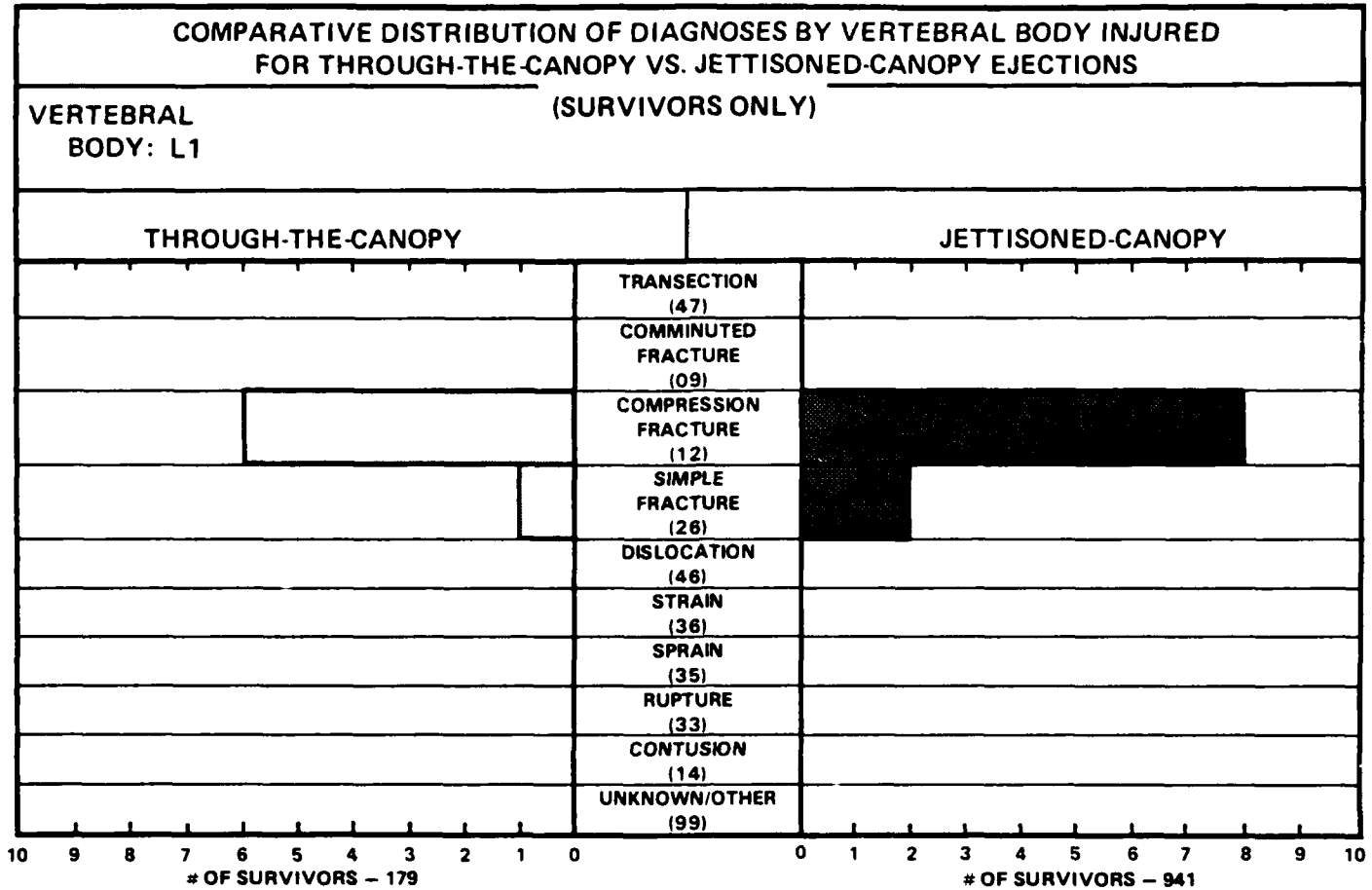
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: T12

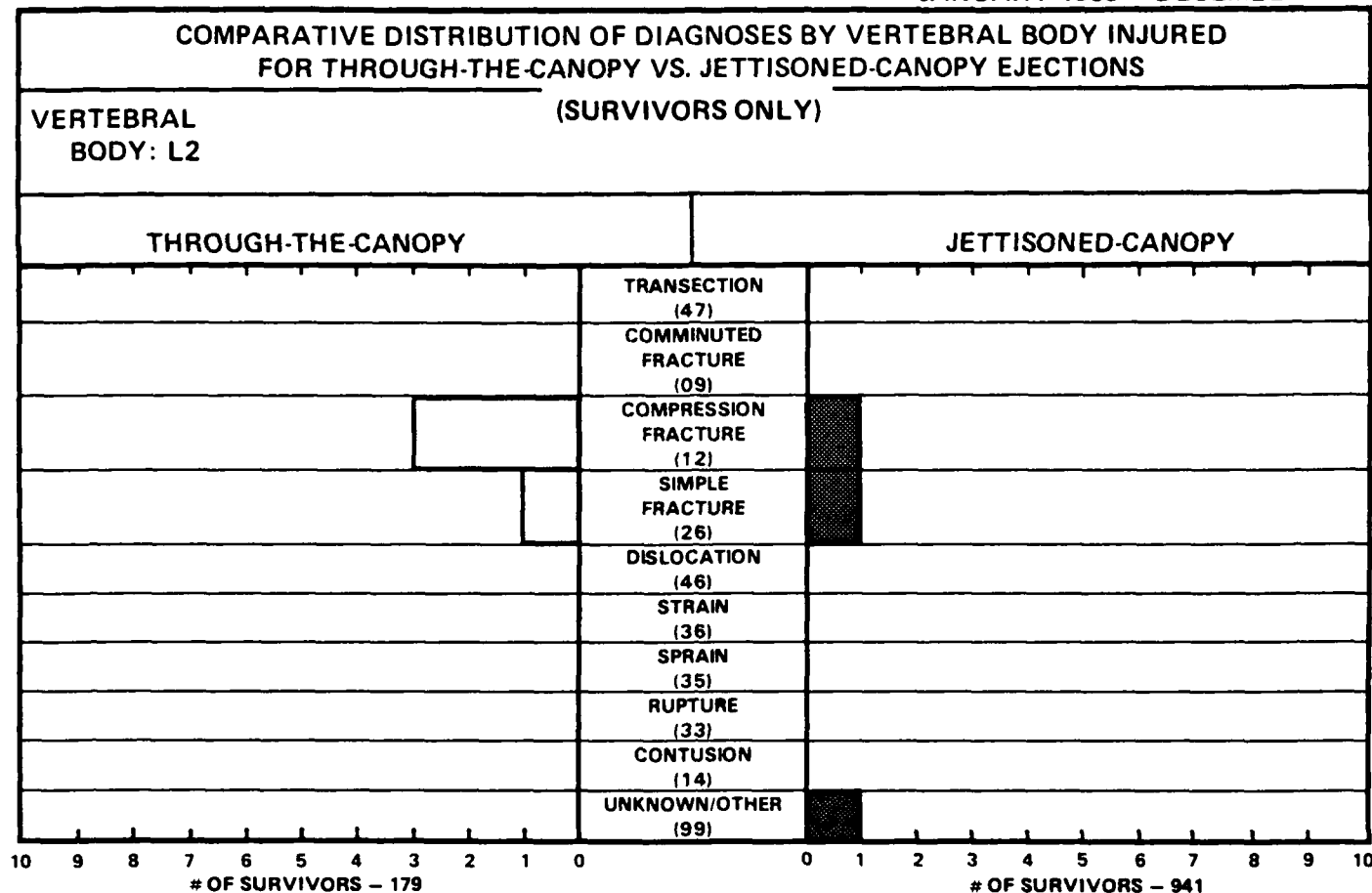
(SURVIVORS ONLY)



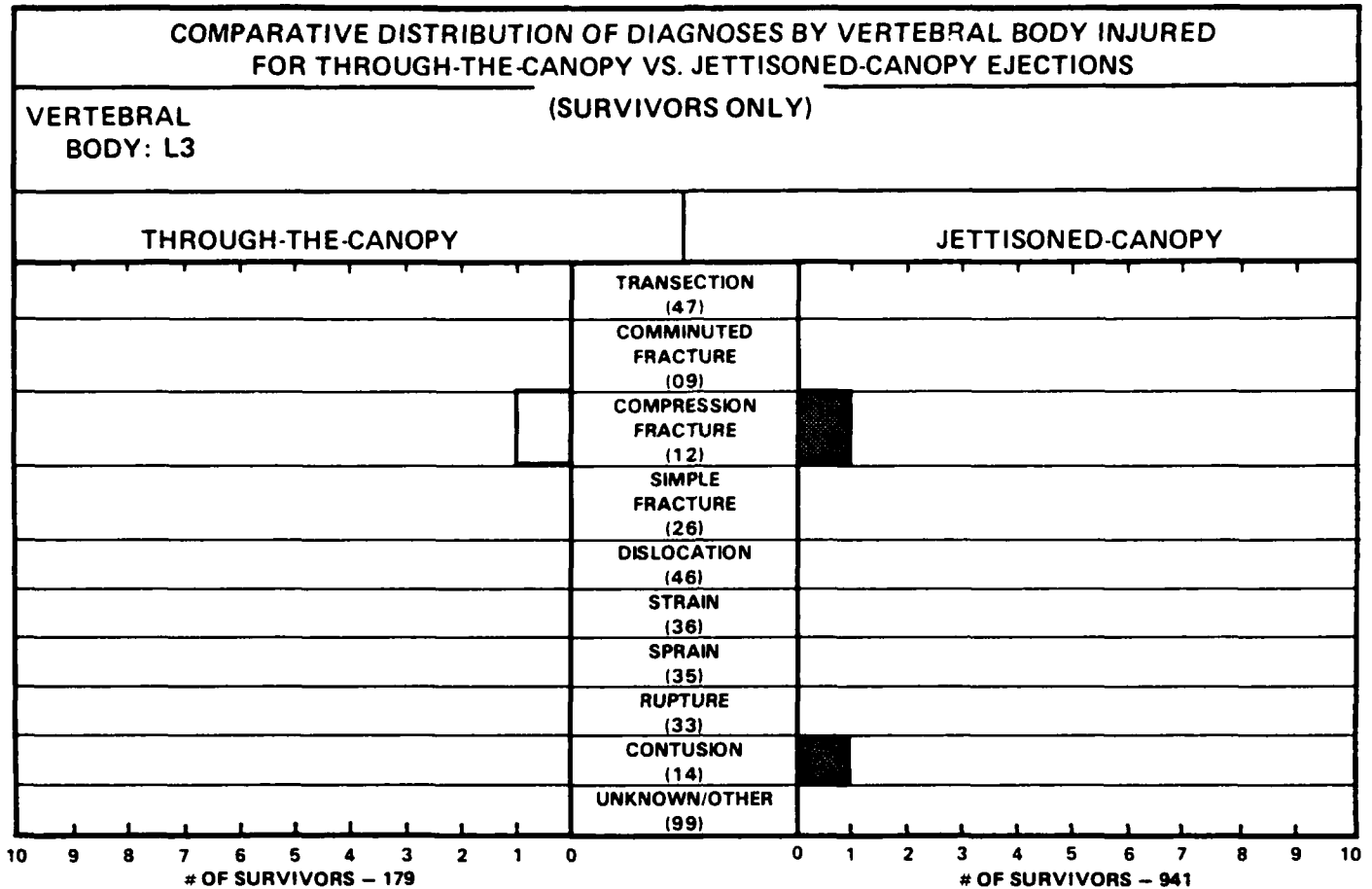
JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979



JANUARY 1969 - DECEMBER 1979

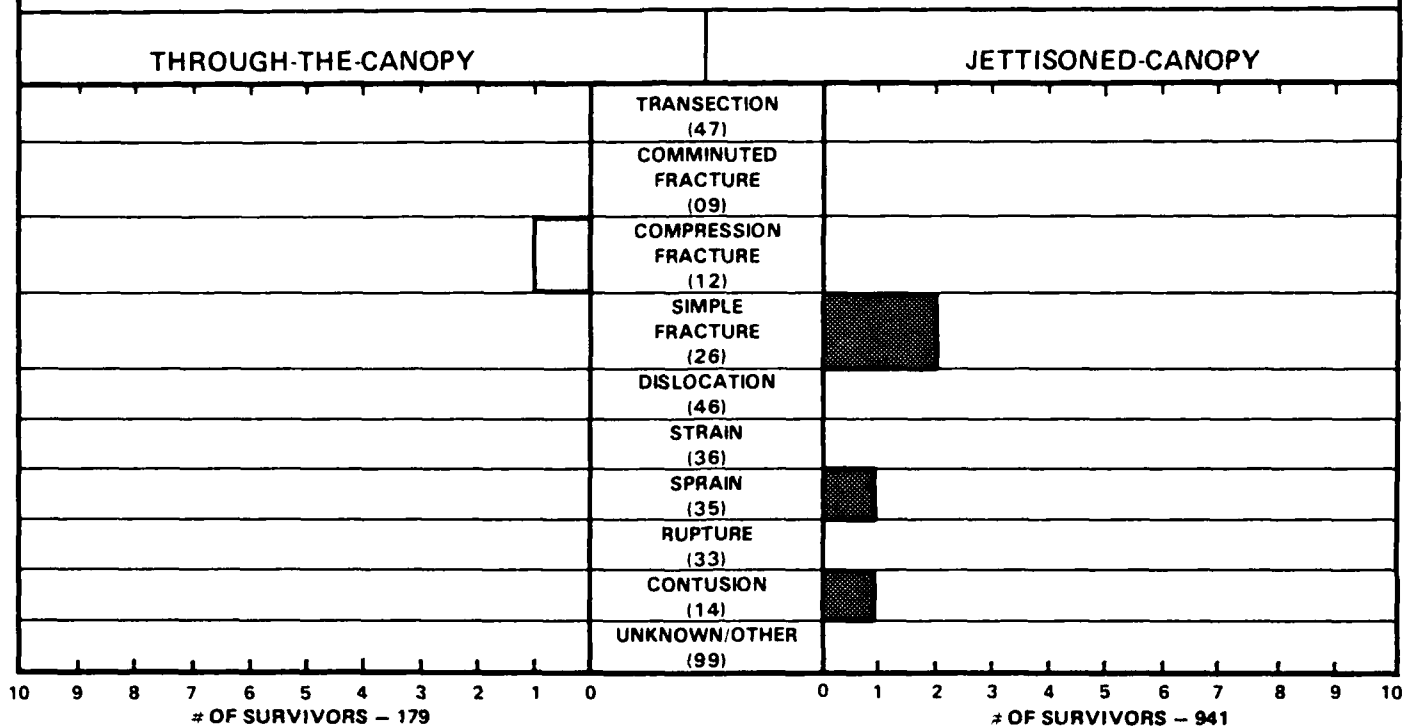


JANUARY 1969 – DECEMBER 1979

COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL
BODY: L4

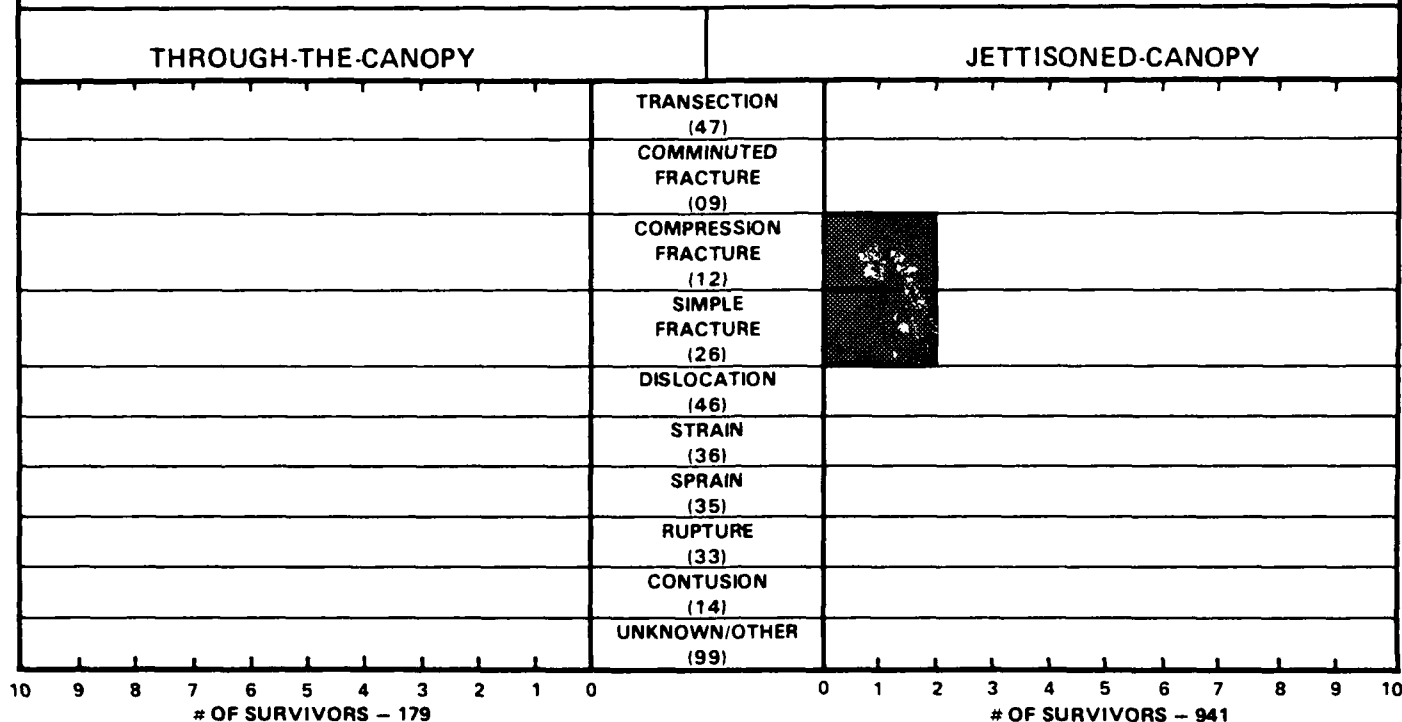
(SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979

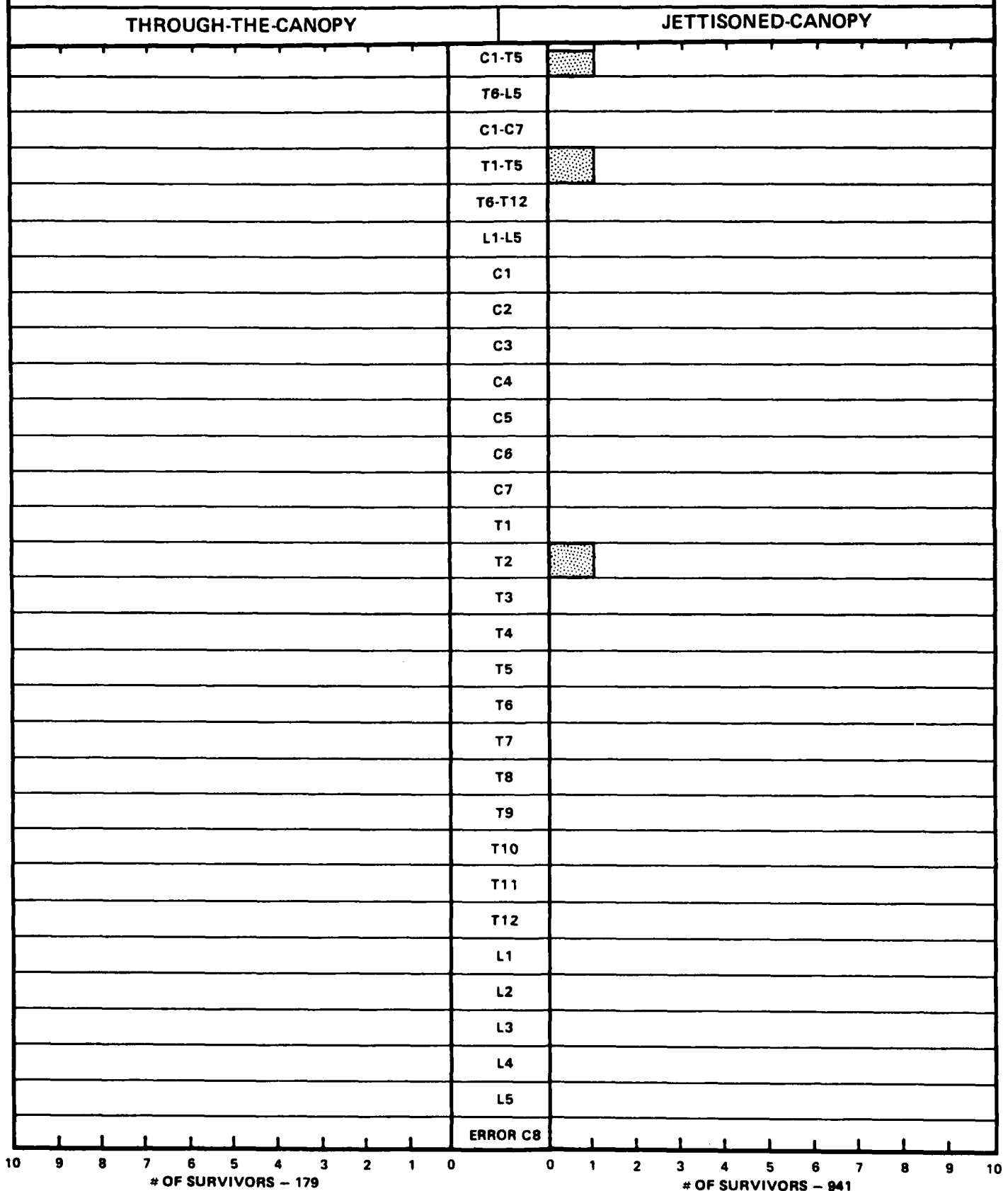
COMPARATIVE DISTRIBUTION OF DIAGNOSES BY VERTEBRAL BODY INJURED
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

VERTEBRAL BODY: L5 (SURVIVORS ONLY)



**COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

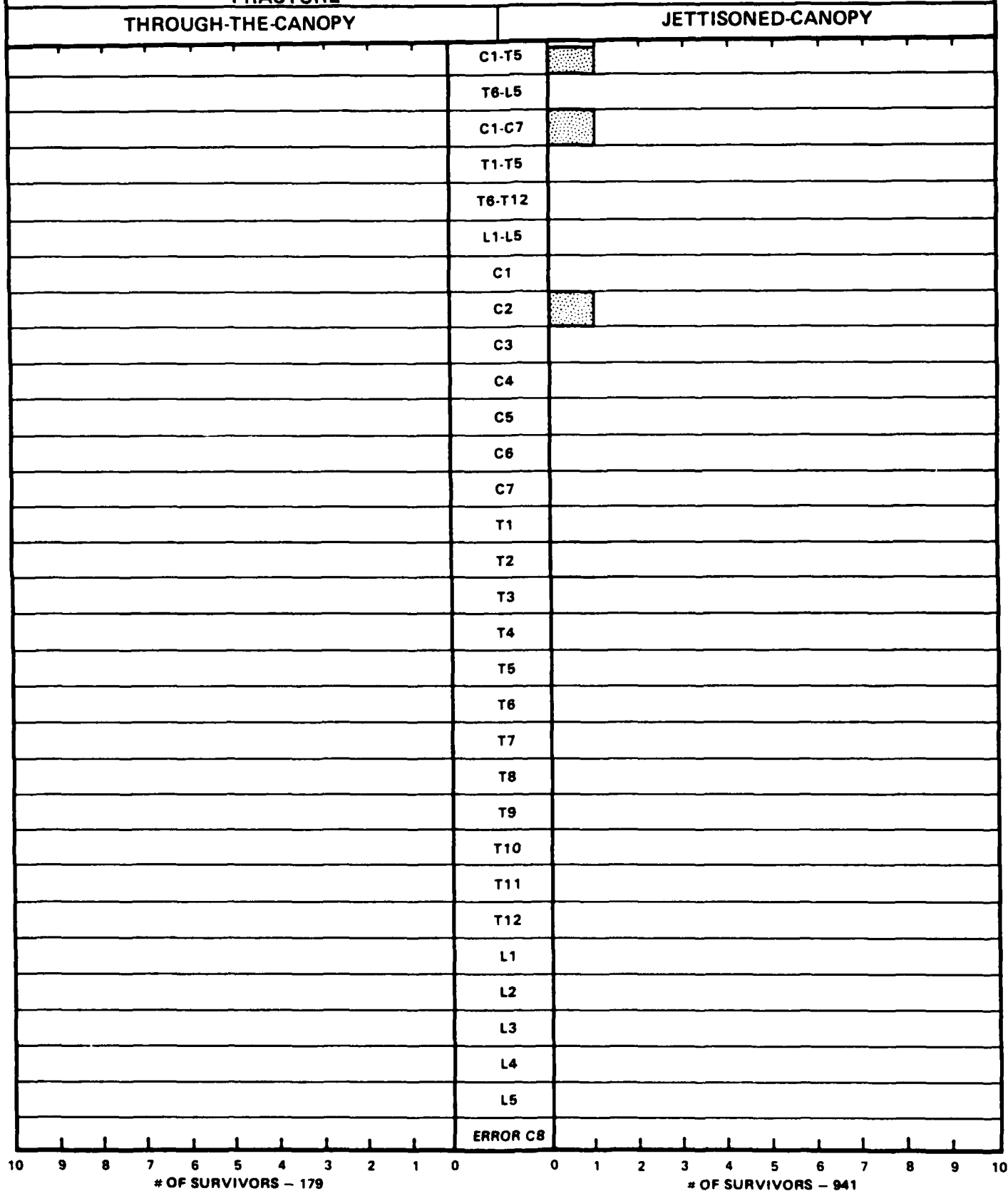
INJURY DIAGNOSIS: TRANSECTION (SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979

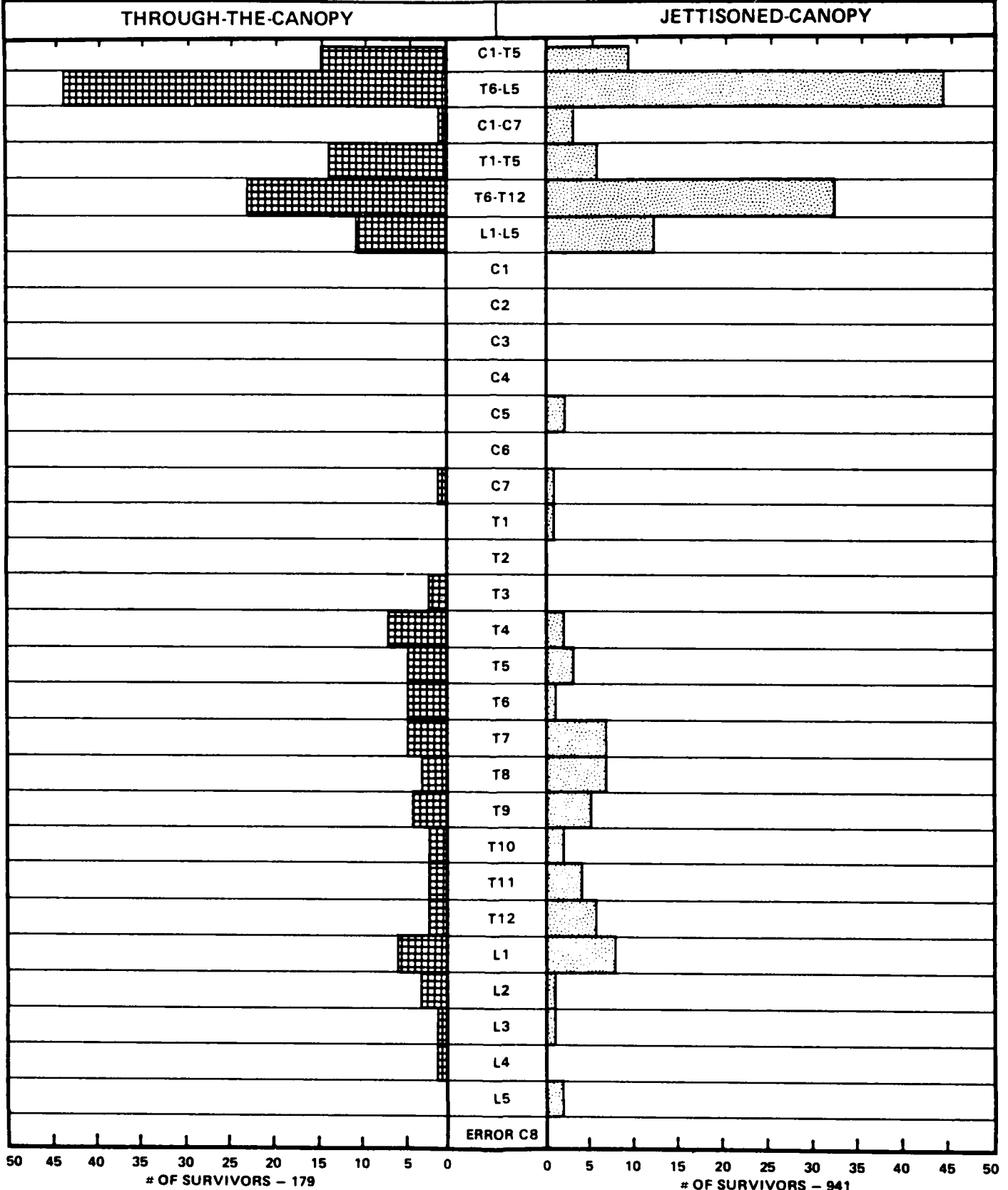
COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

INJURY DIAGNOSIS: **COMMUNUTED FRACTURE** (SURVIVORS ONLY)



**COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

INJURY DIAGNOSIS: COMPRESSION FRACTURE (SURVIVORS ONLY)

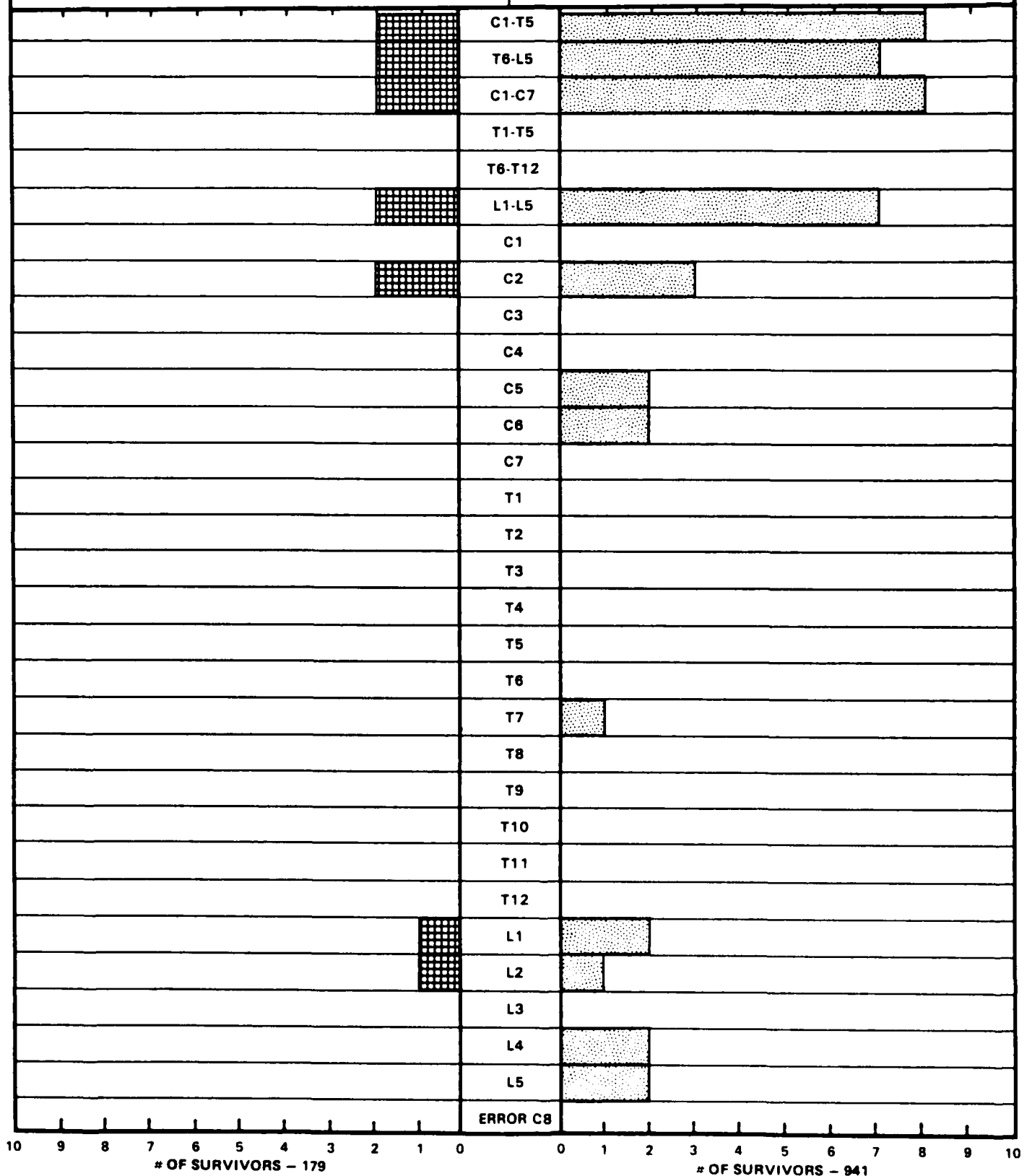


COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

INJURY DIAGNOSIS: SIMPLE FRACTURE (SURVIVORS ONLY)

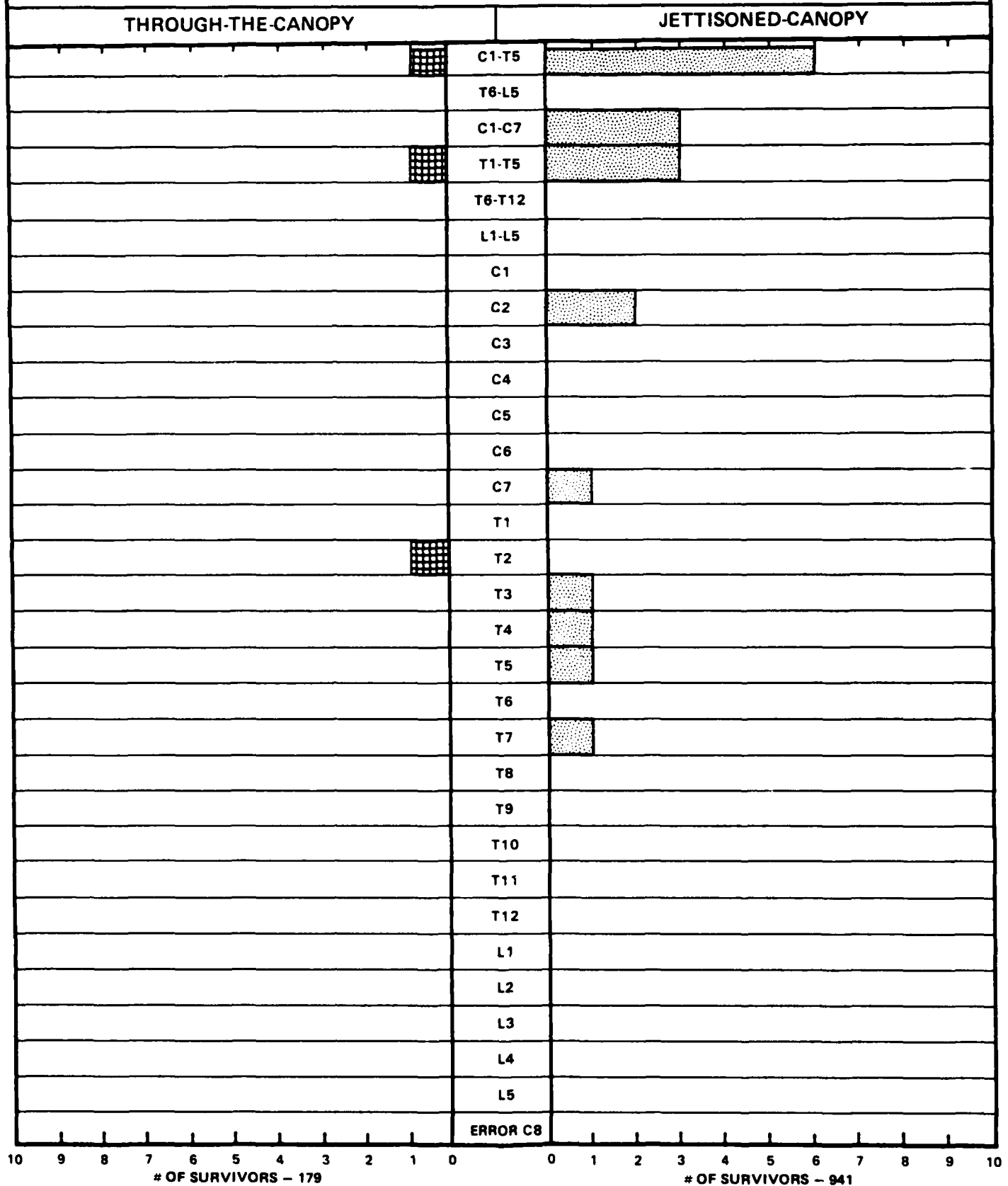
THROUGH-THE-CANOPY

JETTISONED-CANOPY



**COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

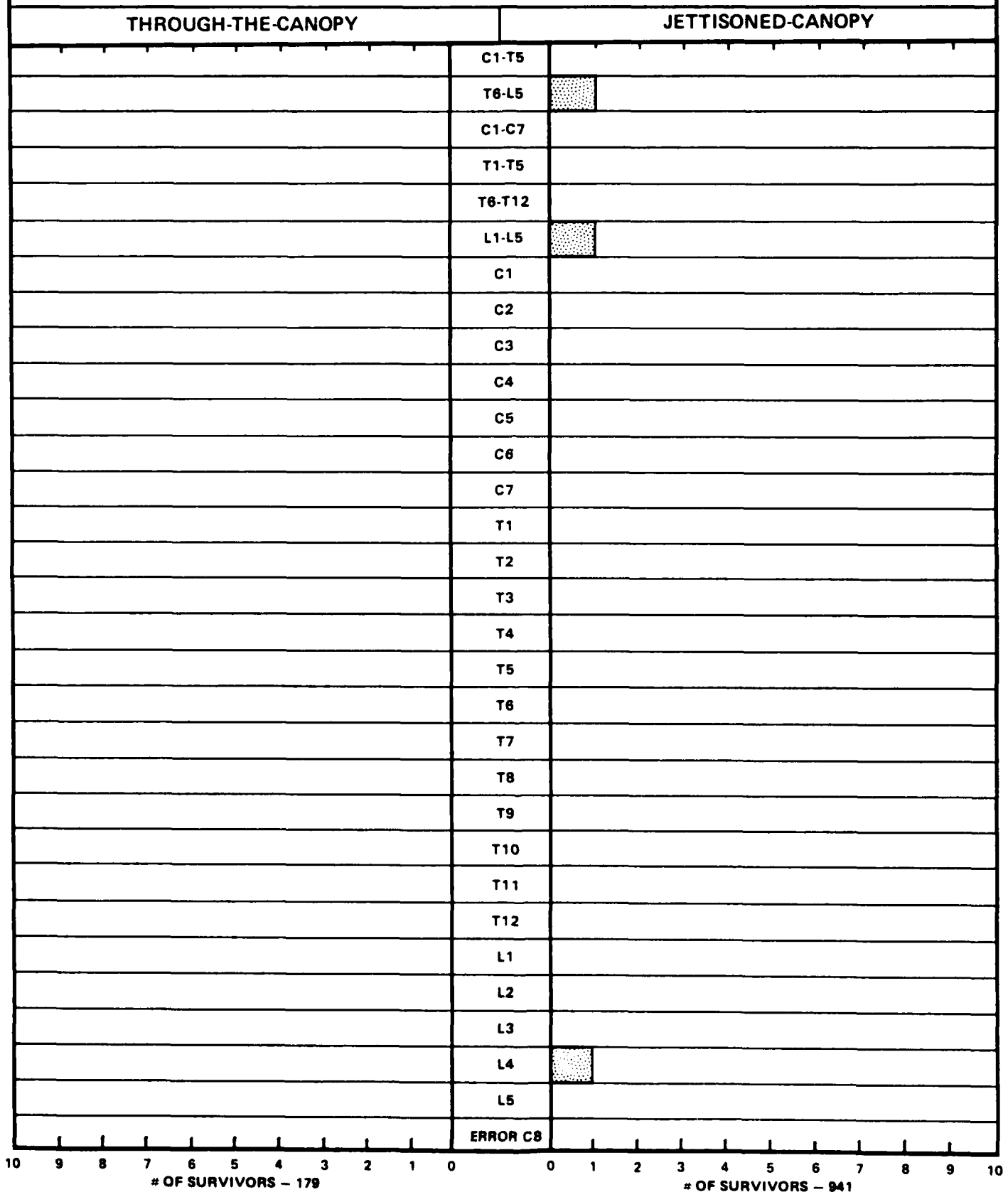
INJURY DIAGNOSIS: STRAIN (SURVIVORS ONLY)



**COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS**

INJURY DIAGNOSIS: SPRAIN

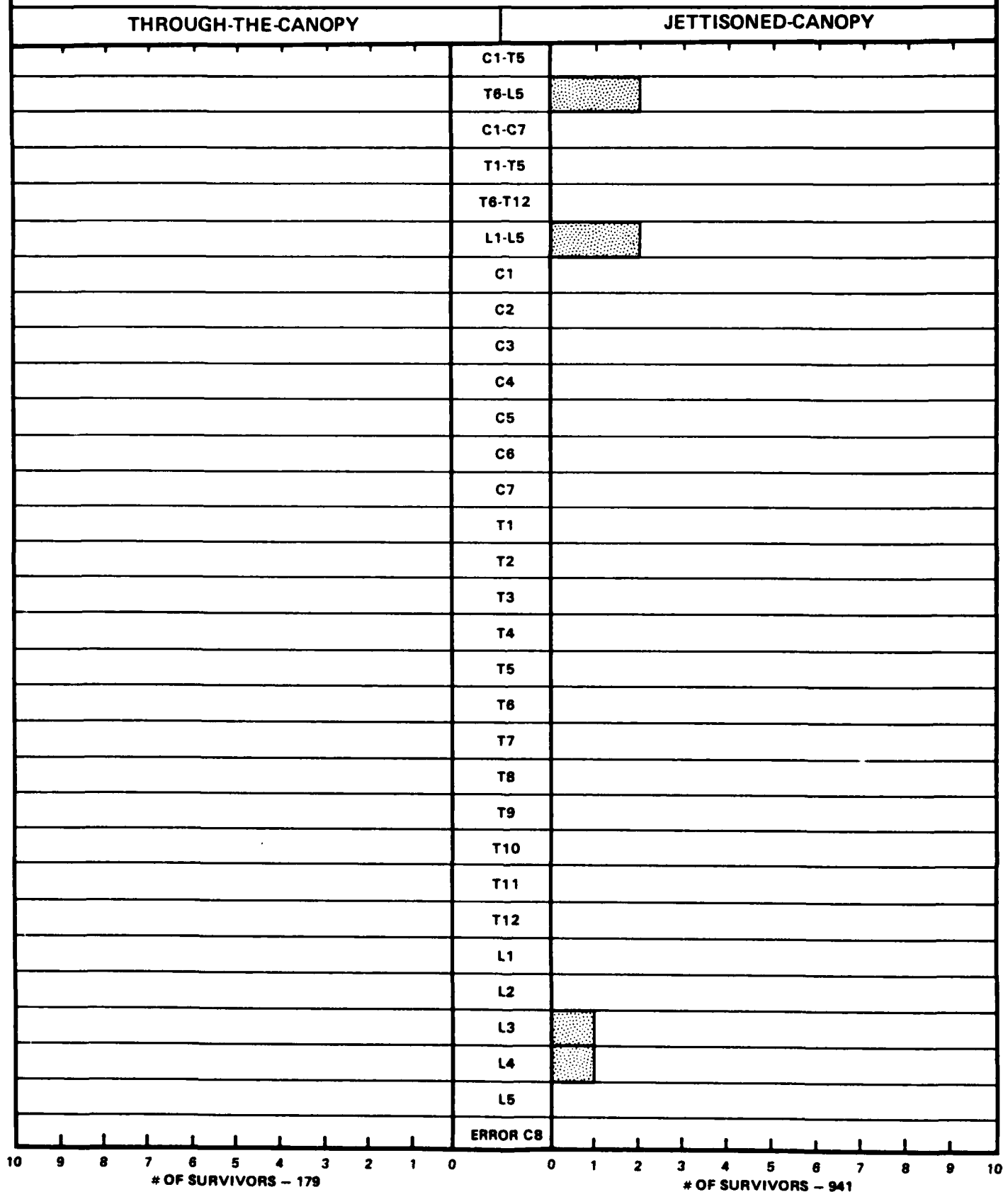
(SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979

COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

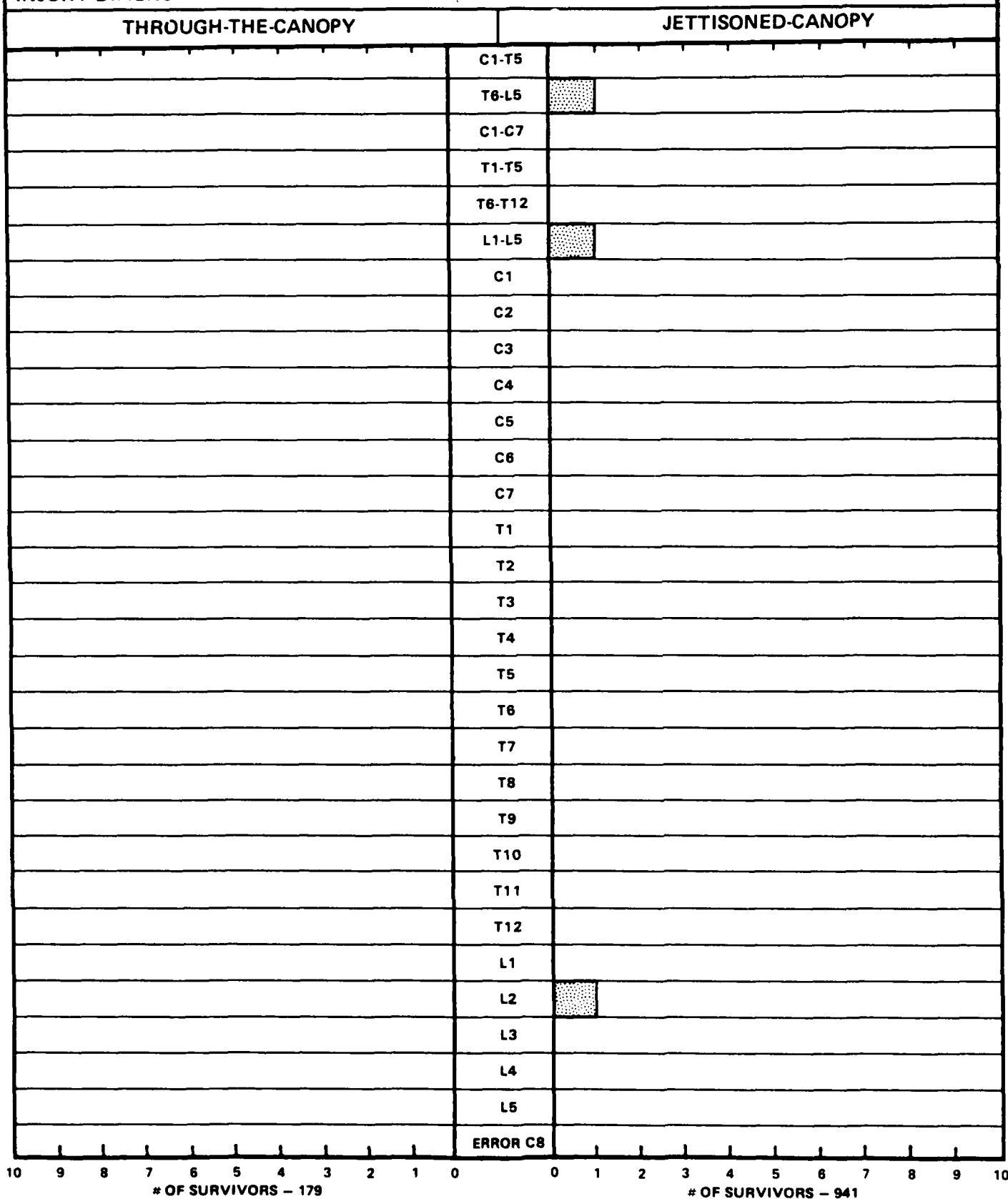
INJURY DIAGNOSIS: CONTUSION (SURVIVORS ONLY)



JANUARY 1969 - DECEMBER 1979

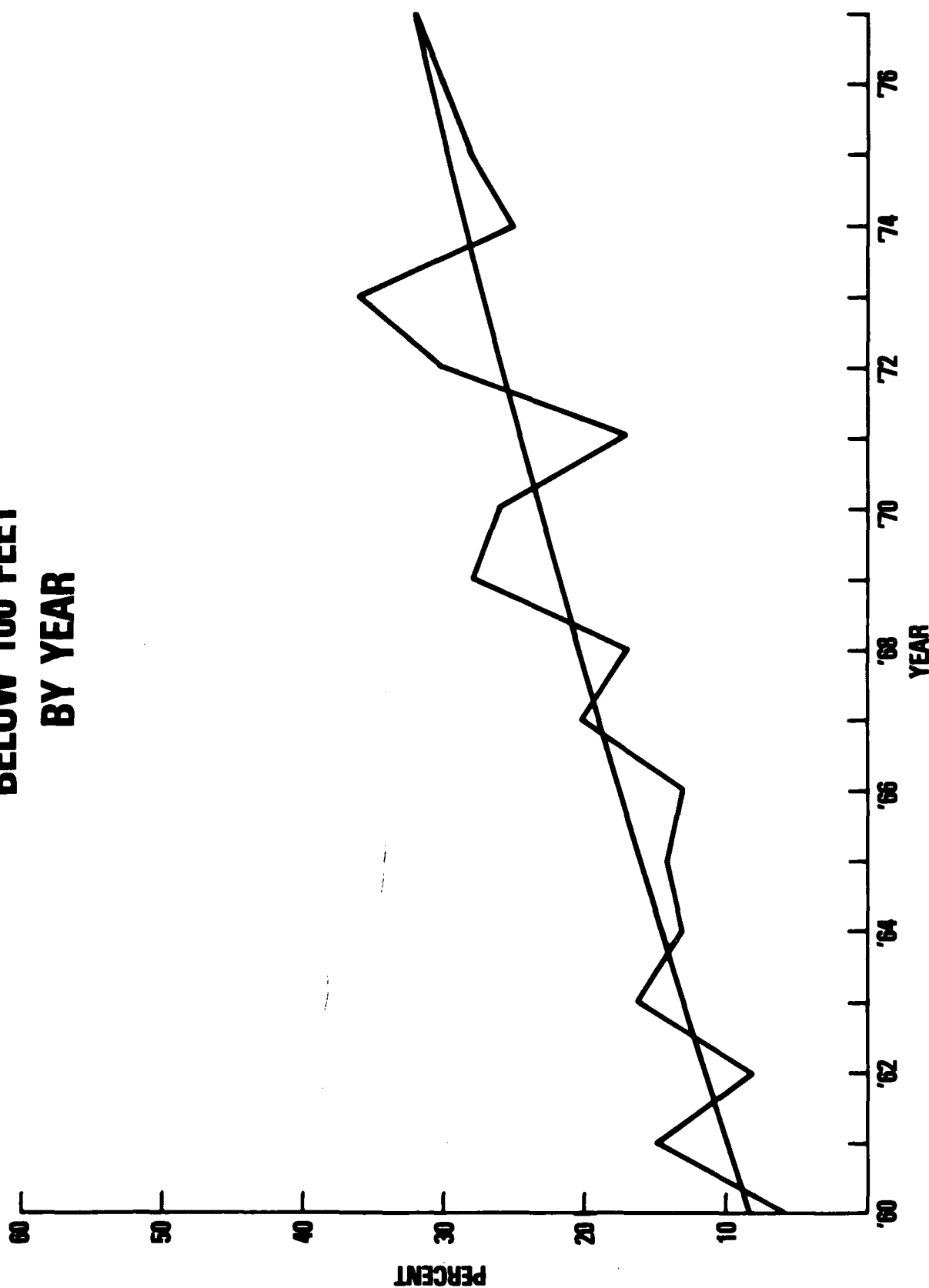
COMPARISON OF INJURED VERTEBRAL BODIES BY INJURY DIAGNOSES
FOR THROUGH-THE-CANOPY VS. JETTISONED-CANOPY EJECTIONS

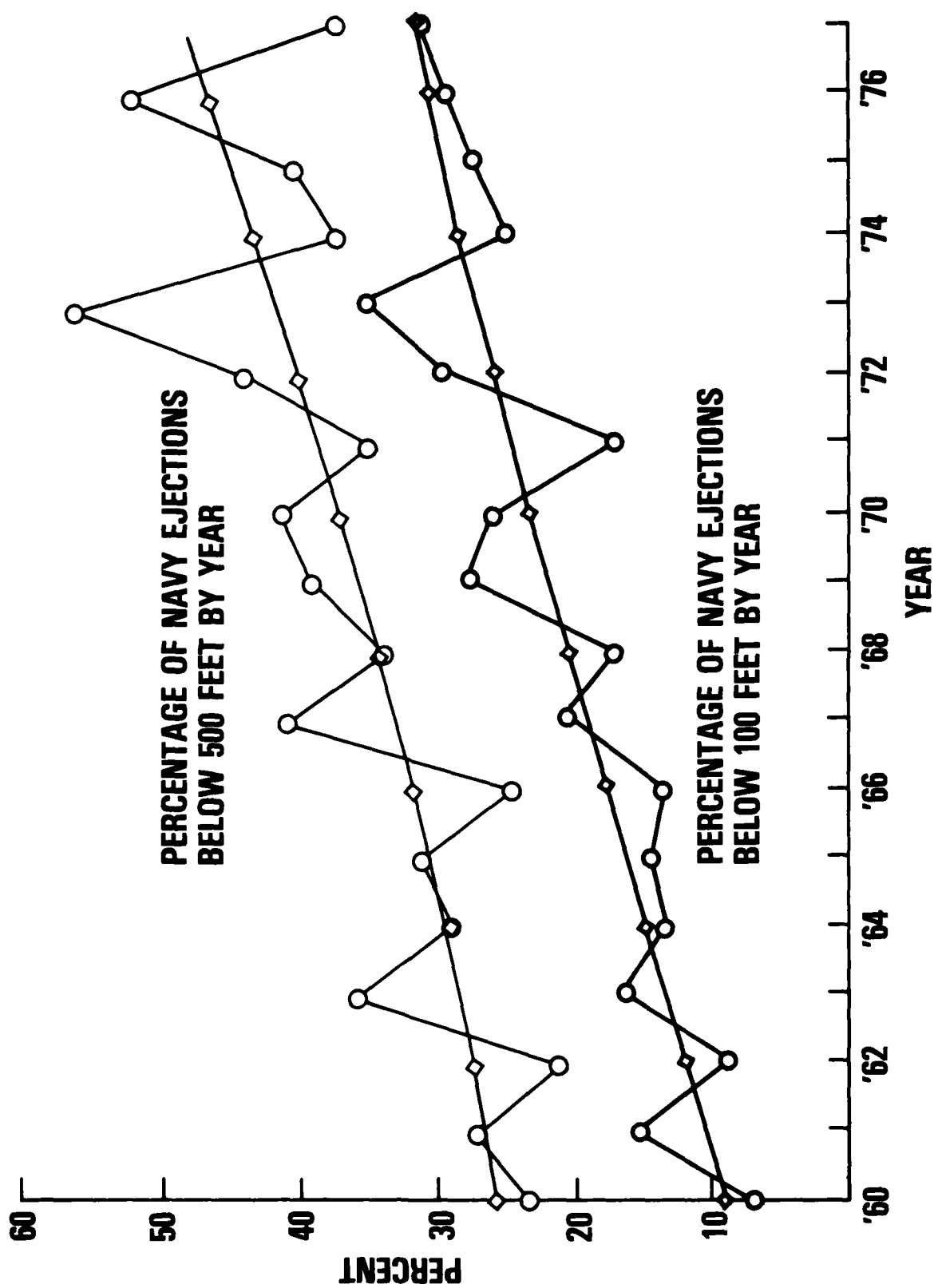
INJURY DIAGNOSIS: UNKNOWN/OTHER (SURVIVORS ONLY)



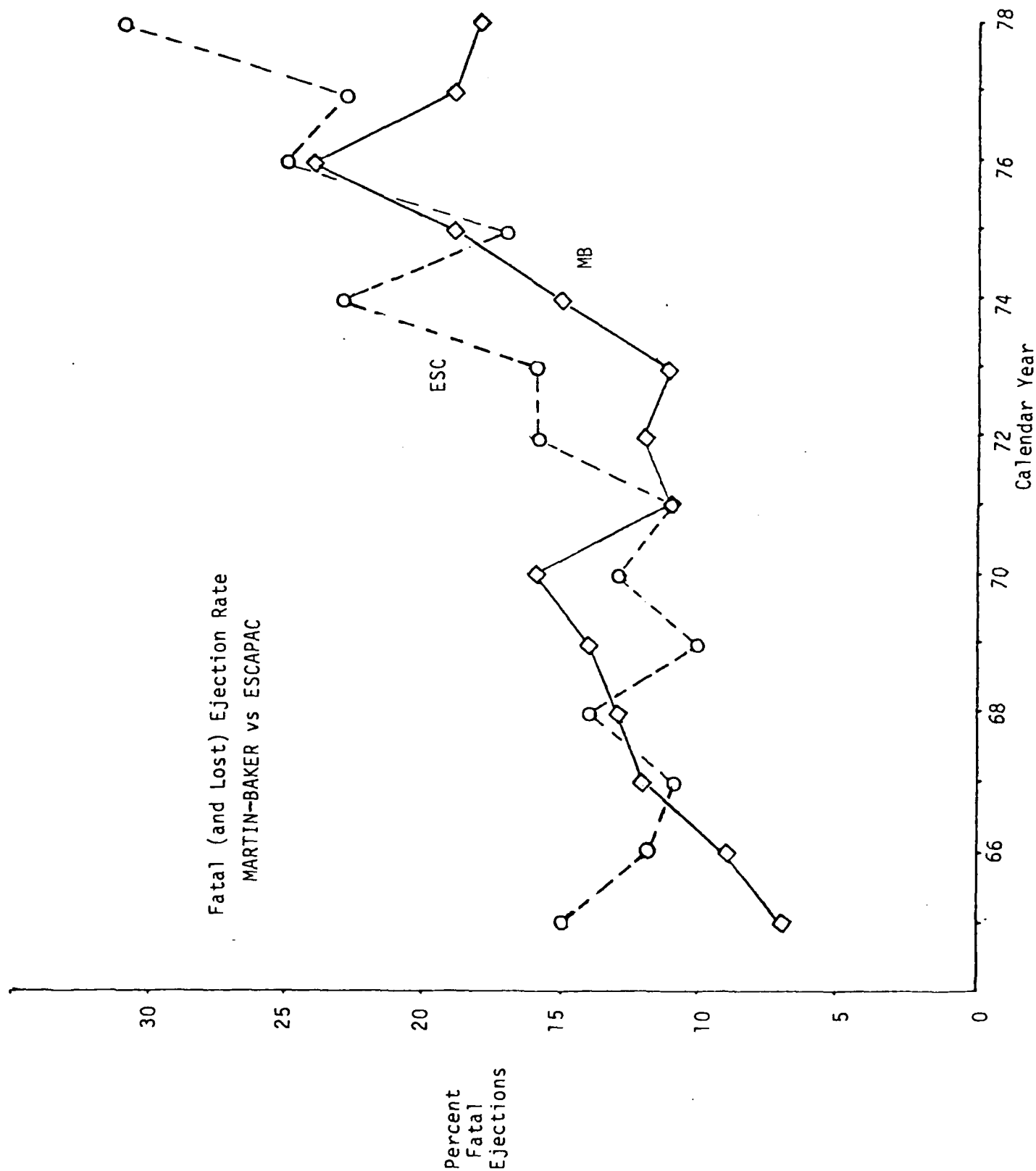
EJECTION STATISTICS &
ANALYSES

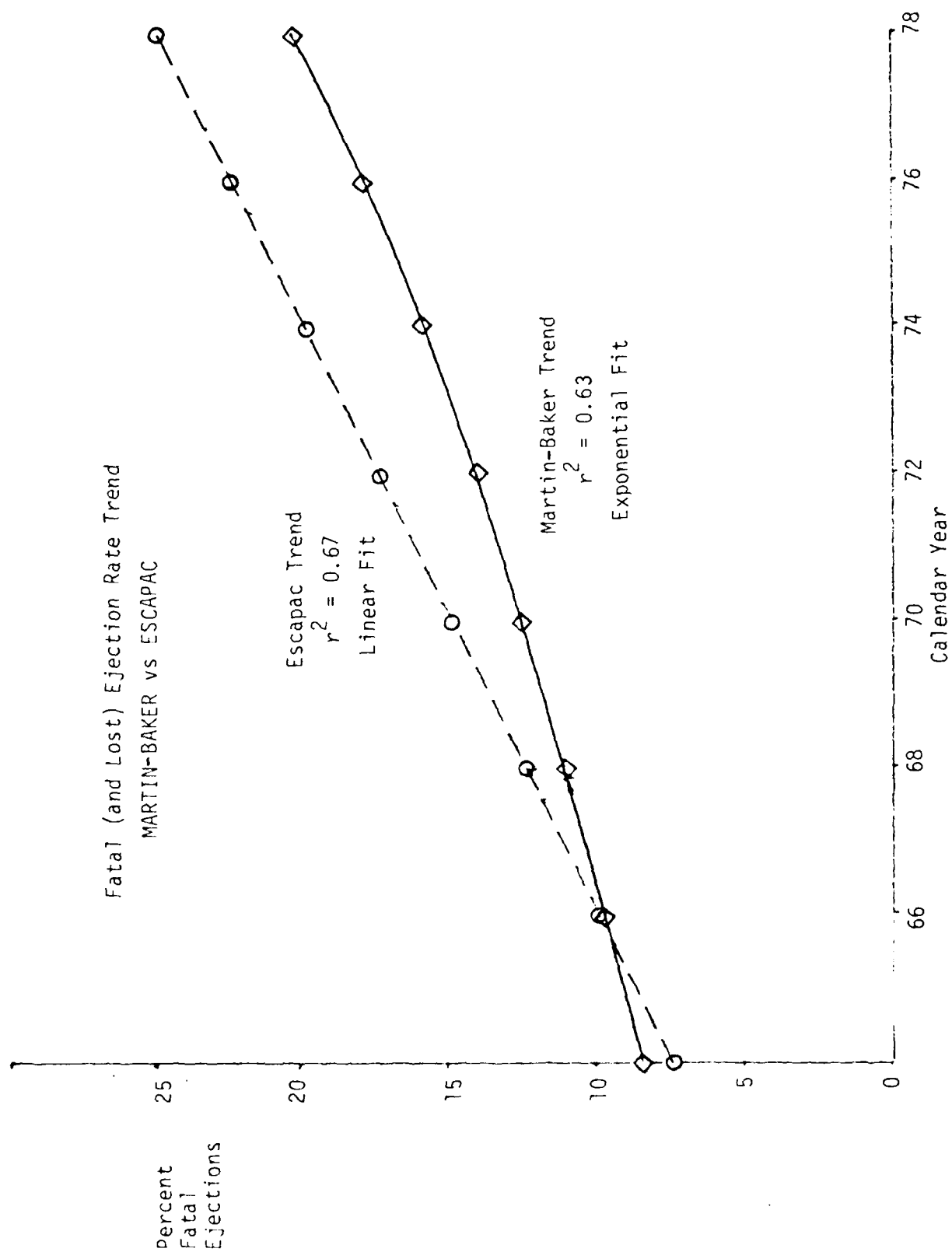
PERCENTAGE OF NAVY EJECTIONS BELOW 100 FEET BY YEAR





Fatal (and Lost) Ejection Rate MARTIN-BAKER vs ESCAPAC

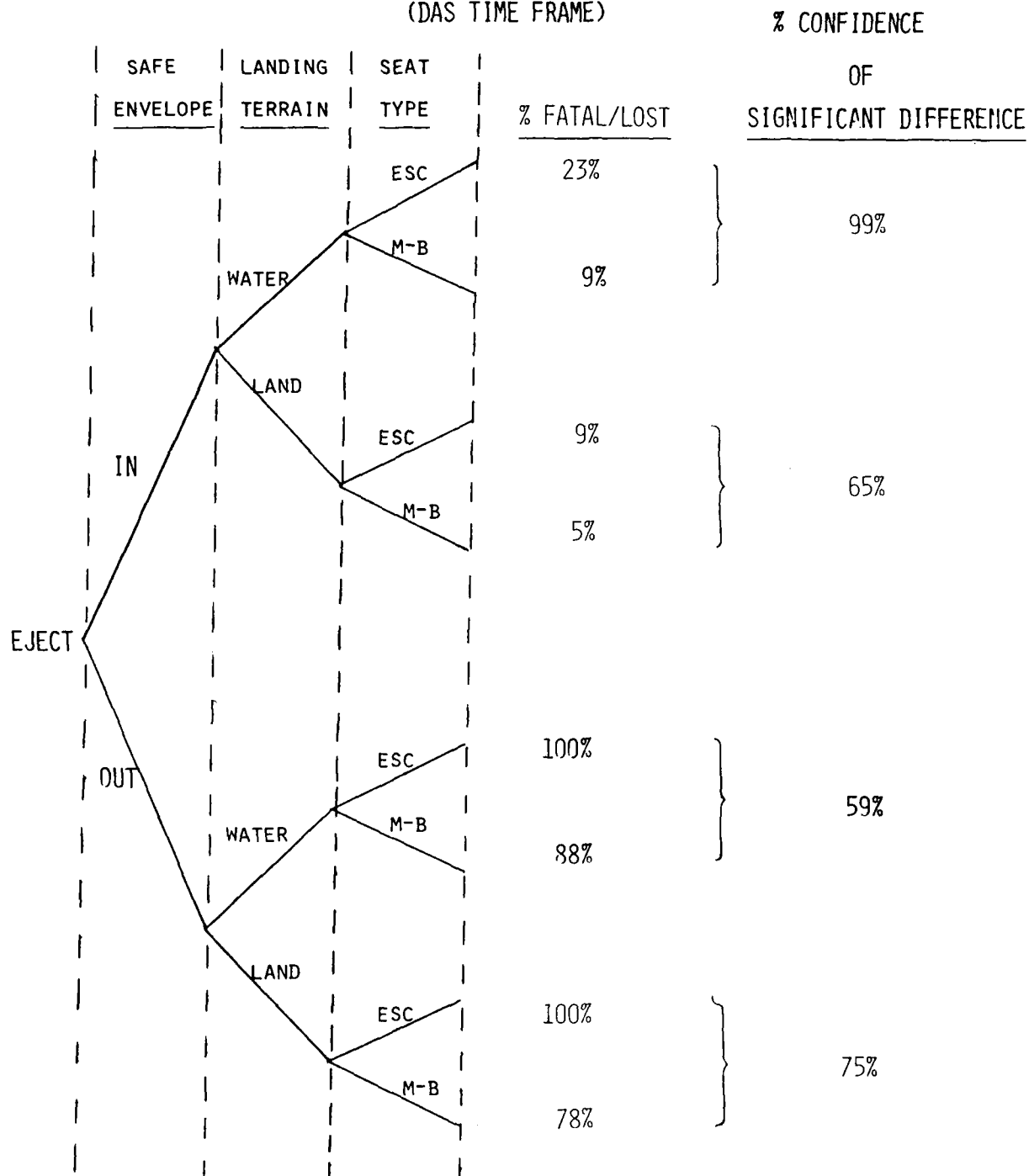




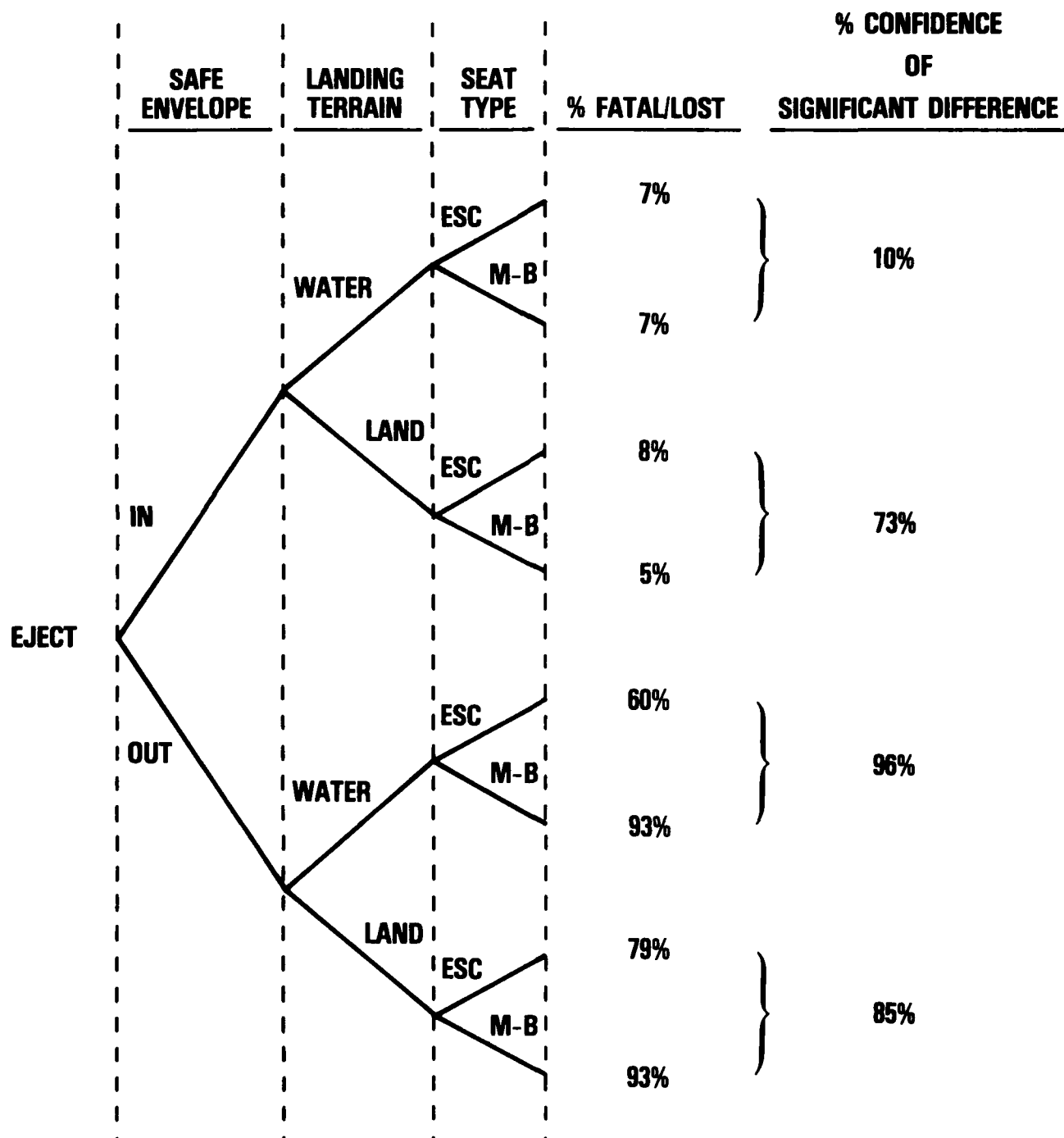
ESCAPAC vs MARTIN-BAKER FATAL/LOST DIAGRAM

(CY1974 THROUGH JUNE 30 1978)

(DAS TIME FRAME)

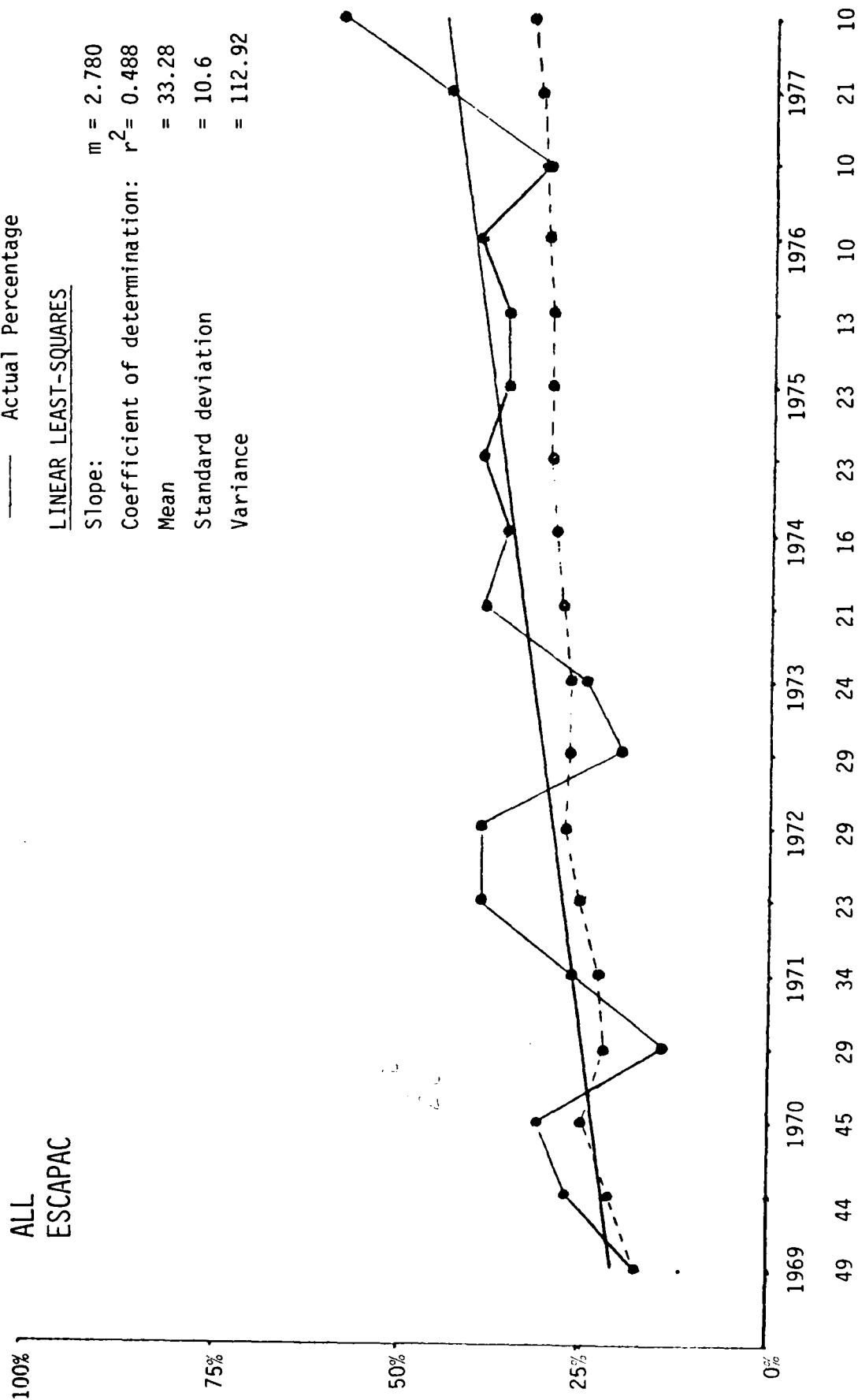


ESCAPAC VS MARTIN-BAKER FATAL/LOST DIAGRAM (CY1969 THROUGH CY1973)



TIME SERIES OF THE % OF ATTEMPTS WITH FATAL OR MAJOR INJURIES OR LOST

----- Cumulative
 ----- Actual Percentage
LINEAR LEAST-SQUARES
 Slope: $m = 2.780$
 Coefficient of determination: $r^2 = 0.488$
 Mean = 33.28
 Standard deviation = 10.6
 Variance = 112.92



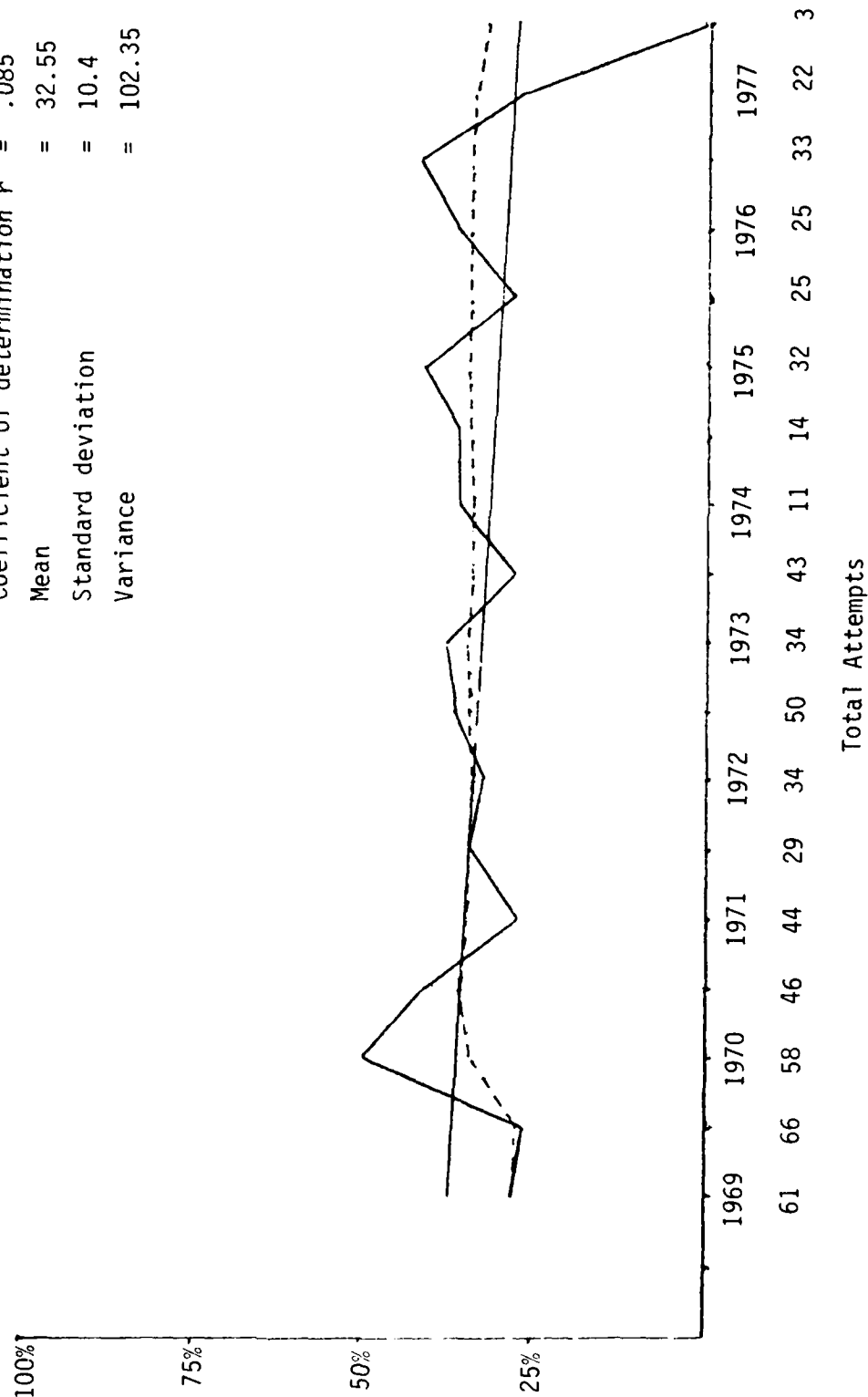
ATTEMPTS

TIME SERIES OF THE % OF ATTEMPTS
WITH FATAL OR MAJOR INJURIES OR LOST
FOR THE MARTIN BAKER SEAT TYPES

--- Cumulative Running Average
— Actual Percentage

LINEAR LEAST SQUARES

Slope: $m = -.570$
Coefficient of determination $r^2 = .085$
Mean = 32.55
Standard deviation = 10.4
Variance = 102.35



CHANGES IN ESCAPAC INJURY RATES OVER THE PAST DECADE

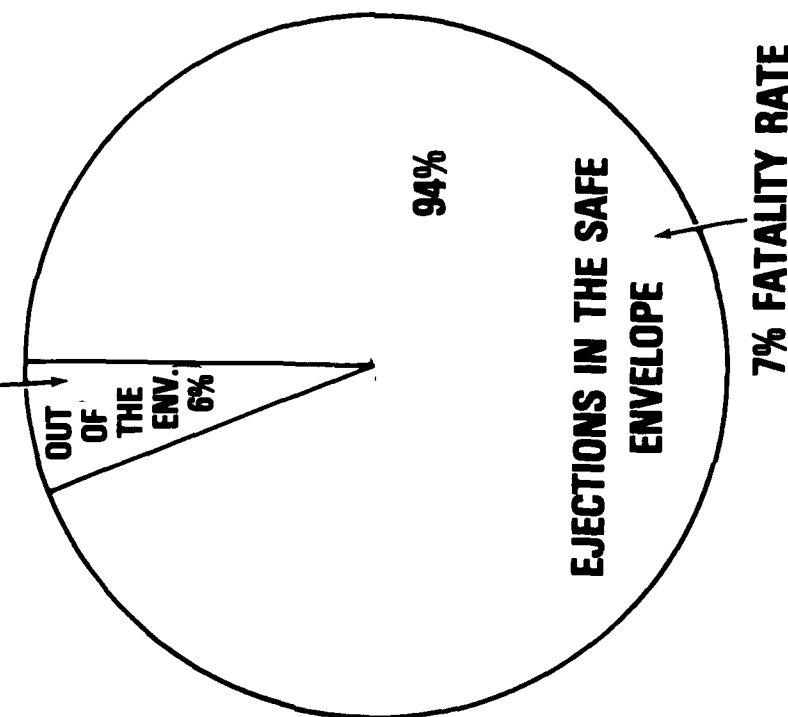
<u>INJURY</u>	<u>1969 - 1973 (INCL.)</u>	<u>1974 - 1978 (INCL.)</u>	<u>Δ</u>
FATAL/LOST	13%	23%	+ 10%
MAJOR	14%	17%	+ 3%
MINOR/MINIMAL/NONE	73%	60%	- 13%
<hr/>			
TOTAL # EJECTIONS	336	149	-187

% CONFIDENCE OF SIGNIFICANT DIFFERENCE 99%

(I.E....AT A CONFIDENCE LEVEL OF 99% THE INJURY CATEGORIES REFLECT TWO DISTINCT SAMPLE POPULATIONS RATHER THAN RANDOM OCCURENCES DRAWN FROM THE SAME POPULATION).

DATA PERIOD : 1/1/69 THRU 12/31/73

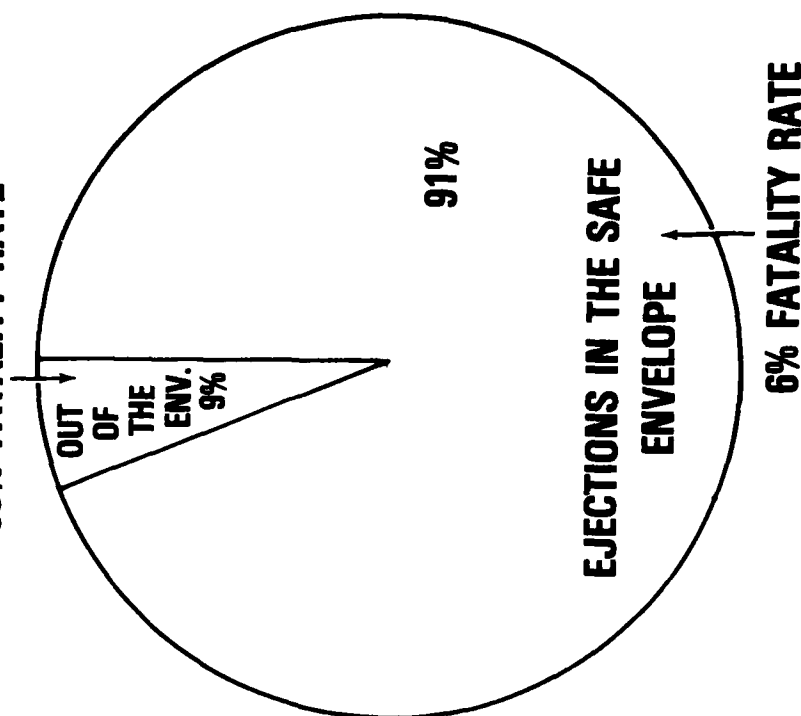
ESCAPAC
72% FATALITY RATE



$$.06 \times 72\% + .94 \times 7\% = 11\%$$

OVERALL
FATALITY
RATE

M-B
93% FATALITY RATE



$$.09 \times 93\% + .91 \times 6\% = 14\%$$

OVERALL
FATALITY
RATE

WHY IS THE FATALITY RATE APPROXIMATELY EQUAL BETWEEN ESCAPAC AND MARTIN-BAKER?

(DAS TIME FRAME 1/1/74-6/30/78)

ESCAPAC

M-B

100% FATALITY RATE

OUT
OF
THE
ENV.
7%

93%

EJECTIONS IN THE SAFE ENVELOPE

15% FATALITY RATE

82% FATALITY
RATE

OUT OF THE
ENVELOPE 17%

83%

EJECTIONS IN THE SAFE ENVELOPE

8% FATALITY RATE

$$.07 \times 100\% + .93 \times 15\% = 21\%$$

OVERALL
FATALITY
RATE

$$.17 \times 82\% + .83 \times 8\% = 21\%$$

OVERALL
FATALITY
RATE

FATALITY RATE COMPARISON BETWEEN

ESCAPAC IA-1, IC-2, IC-3 AND ESCAPAC IE-1, IF-3, IG-2, IG-3

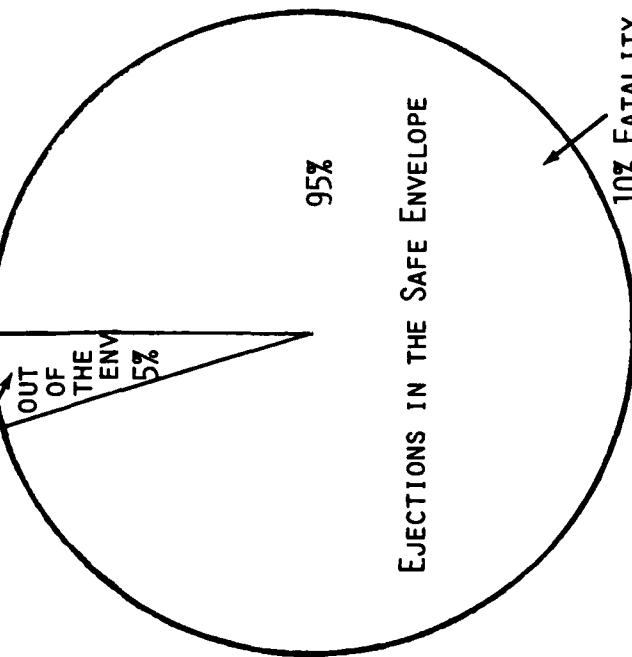
(DAS TIME FRAME 1/1/74-6/30/78)

ESCAPAC IA-1, IC-2, IC-3

ESCAPAC IE-1, IF-3, IG-2, IG-3

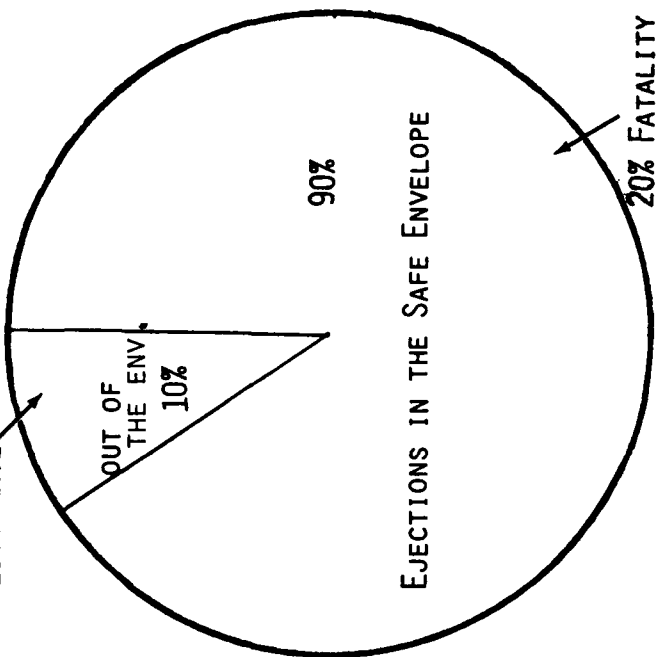
100% FATALITY RATE

88% FATALITY RATE



$$.05 \times 100\% + .95 \times 10\% = 14\%$$

OVERALL
FATALITY
RATE



$$.10 \times 88\% + .90 \times 20\% = 27\%$$

OVERALL
FATALITY
RATE

(1/1/74-6/30/78)

COMPARATIVE FATALITY RATES

ESCAPAC IA-1, IC-2, IC-3 vs IE-1, IF-3, IG-2, IG-3

EJECTIONS IN THE SAFE ENVELOPE

	<u>#</u>	<u>%</u>	<u>%</u>
	EJECT	SURVIVORS	FATAL & LOST
IA-1, IC-2, IC-3	58	90%	10%
IE-1, IF-3, IG-2, IG-3	71	80%	20%

% CONFIDENCE

OF

SIGNIFICANT DIFFERENCE

86%

COMPARATIVE FATALITY RATES

(1/1/74-6/30/78)

ESCAPAC IA-1, IC-2, IC-3, vs IE-1, IF-3, IG-2, IG-3

EJECTIONS OUT OF THE SAFE ENVELOPE

	# EJECT	% SURVIVORS	% FATAL & LOST
IA-1, IC-2, IC-3	3	0%	100%
IE-1, IF-3, IG-2, IG-3	8	12%	88%

% CONFIDENCE

OF

SIGNIFICANT DIFFERENCE

48%

1/1/74 - 6/30/78

% OF EJECTIONS IN vs OUT OF THE ENVELOPE

<u>SEAT</u>	<u>TOTAL EJECTIONS</u>	<u>% IN THE ENVELOPE</u>	<u>% OUT OF THE ENVELOPE *</u>
ESCAPAC	140	93%	7%
MARTIN-BAKER	230	83%	17%

% CONFIDENCE
OF

SIGNIFICANT DIFFERENCE

99%

* IN PART REPRESENTS DEGREE OF AIRCREW OVER-CONFIDENCE IN SYSTEM.

1/1/74 - 6/30/78

COMPARATIVE FATALITY
RATES
IN THE SAFE ENVELOPE
LAND & WATER

SEAT	# EJECTIONS	% SURVIVORS	% FATAL & LOST*
ESCAPAC	130	85%	15%
MARTIN-BAKER	191	92%	8%

% CONFIDENCE
OF
SIGNIFICANT DIFFERENCE

97%

* ESCAPAC FATALITY RATE FOR ALL "IN ENVELOPE" ESCAPE ATTEMPTS TWICE THAT OF MARTIN-BAKERS

1/1/74 - 6/30/78

COMPARATIVE FATALITY RATES

WHILE

EJECTING IN THE SAFE ENVELOPE

WATER ONLY

SEAT	# EJECTIONS	% TOTAL & LOST	% SURVIVORS
ESCAPAC	56	23%	77%
MARTIN-BAKER	117	9%	91%

% CONFIDENCE

OF

SIGNIFICANT DIFFERENCE

99%

* ESCAPAC FATALITY RATE FOR ALL "IN ENVELOPE - WATER" EJECTION ATTEMPTS GREATER THAN 2X LARGER THAN MBA'S

(PAGE 14)

"THE ESCAPAC SEAT IN THE A-7 AIRCRAFT HAS... ONE OF THE BEST RATES (85% PERCENT) IN THE NAVY".

• ALL A-7 ESCAPACs

FATAL	10 (18%)
MAJ. INJ.	10 (18%)
TOTAL	57

-175

• HOWEVER, THIS MASKS SIGNIFICANT EFFECTS RESULTING FROM UPGRADING ESCAPAC IC-2 TO ESCAPAC IG-2:

	<u>ESCAPAC IC-2</u>	<u>ESCAPAC IG-2</u>
FATAL	0 (0%)	10 (31%)
MAJ. INJ.	5 (20%)	5 (16%)
TOTAL	25	32

(DATA 1/1/74 THROUGH 6/30/78)

ESCAPAC FATAL/LOST INJURIES

COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS

A-4

IA-1
14
16%

DATES: 69-78

IC-3
17
13%

DATES: 69-77

IF-3
4
20%

DATES: 72-77

IG-3
7
20%

DATES: 74-78

A-7

IC-2
19
12%

DATES: 69-76

IG-2
10
29%

DATES: 75-78

S-3

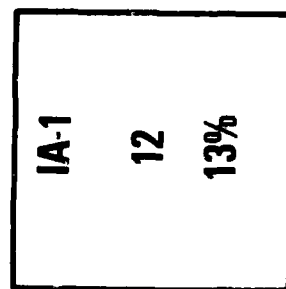
IE-1
7
64%

DATES: 73-78

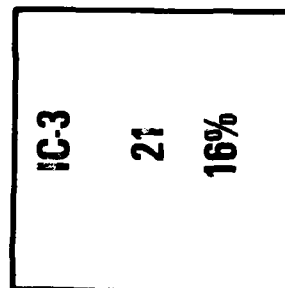
ESCAPAC MAJOR INJURIES

COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS

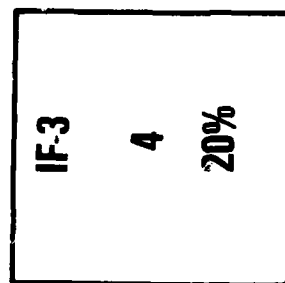
A-4



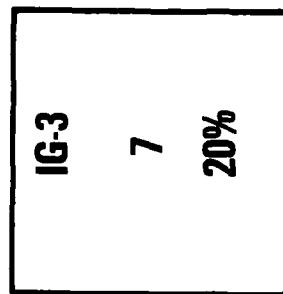
DATES: 69-78



DATES: 69-77

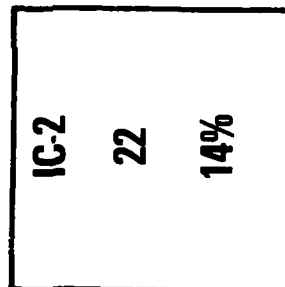


DATES: 72-77

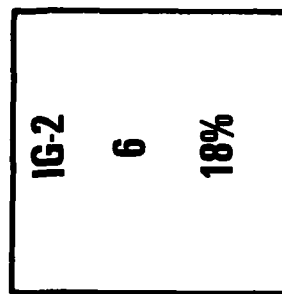


DATES: 74-78

A-7

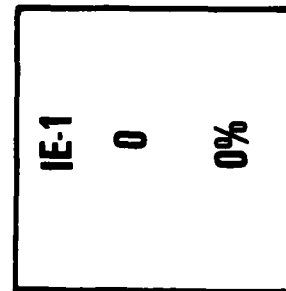


DATES: 69-76



DATES: 75-78

S-3



DATES: 73-78

ESCAPAC MAJOR INJURIES **COMPARATIVE INCIDENCE RATES** **AMONG SURVIVORS & NON-LOST/IMPACT MULTIPLE** **EXTREME FATALITIES**

A-4

IA-1
12
15%

DATES: 69-78

IC-3
21
19%

DATES: 64-77

IF-3
4
21%

DATES: 72-77

IG-3
7
23%

DATES: 74-78

A-7

IC-2
22
15%

DATES: 69-76

IG-2
6
21%

DATES: 75-78

S-3

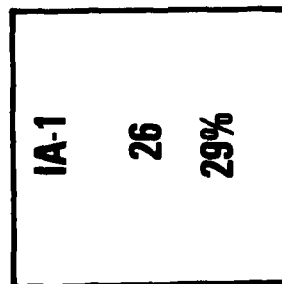
IE-1
0
0%

DATES: 73-78

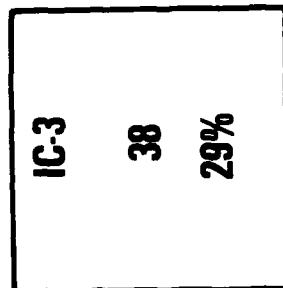
ESCAPAC FATAL/LOST & MAJOR INJURIES

COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS

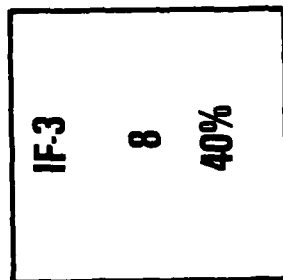
A-4



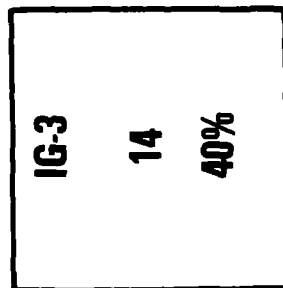
DATES: 69-78



DATES: 69-77

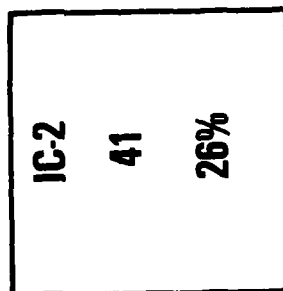


DATES: 72-77

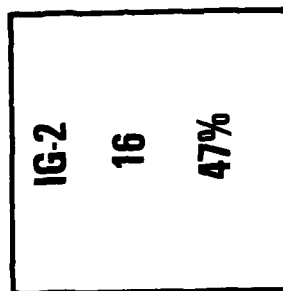


DATES: 74-78

A-7

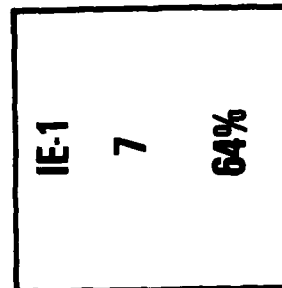


DATES: 69-76



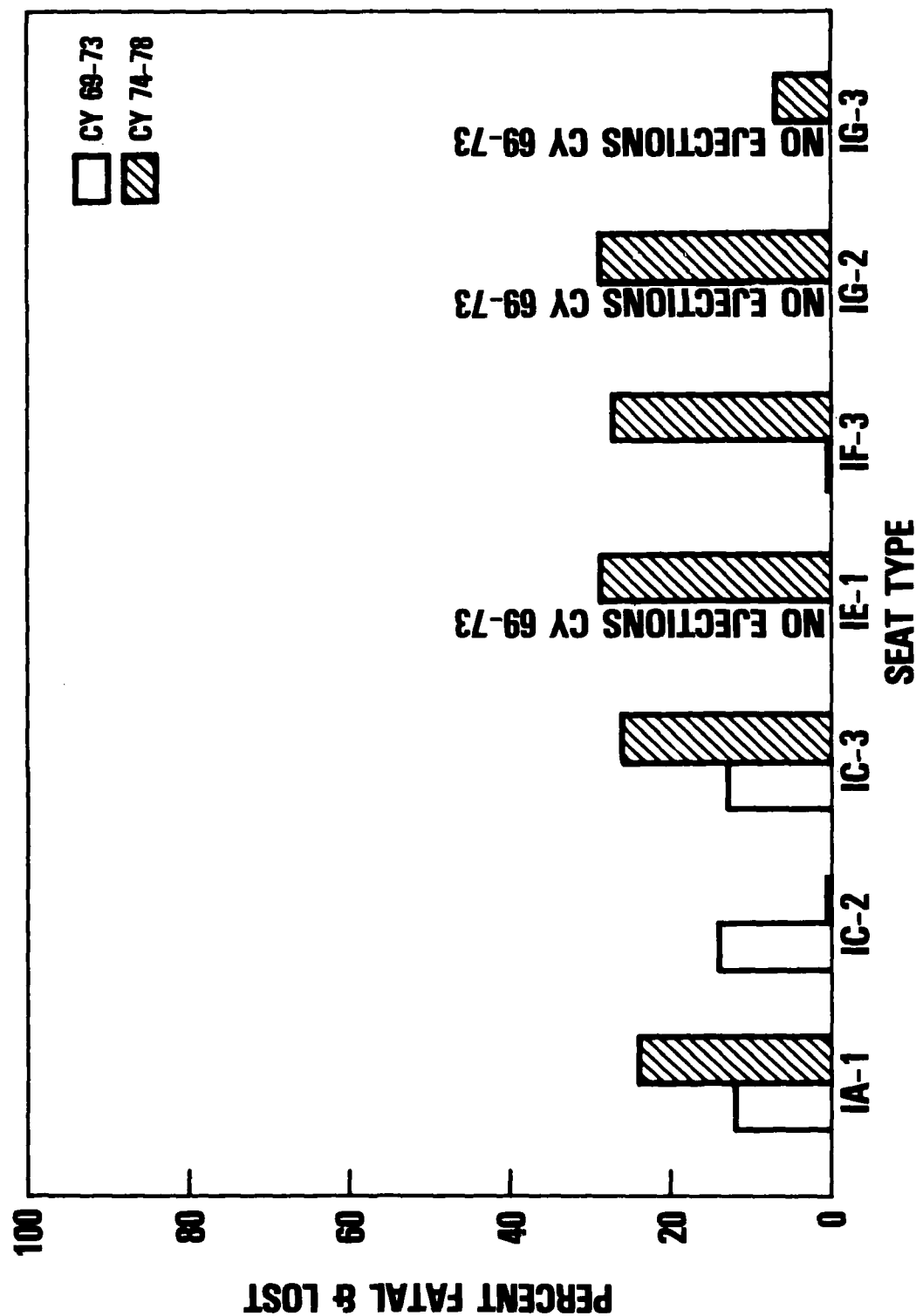
DATES: 75-78

S-3

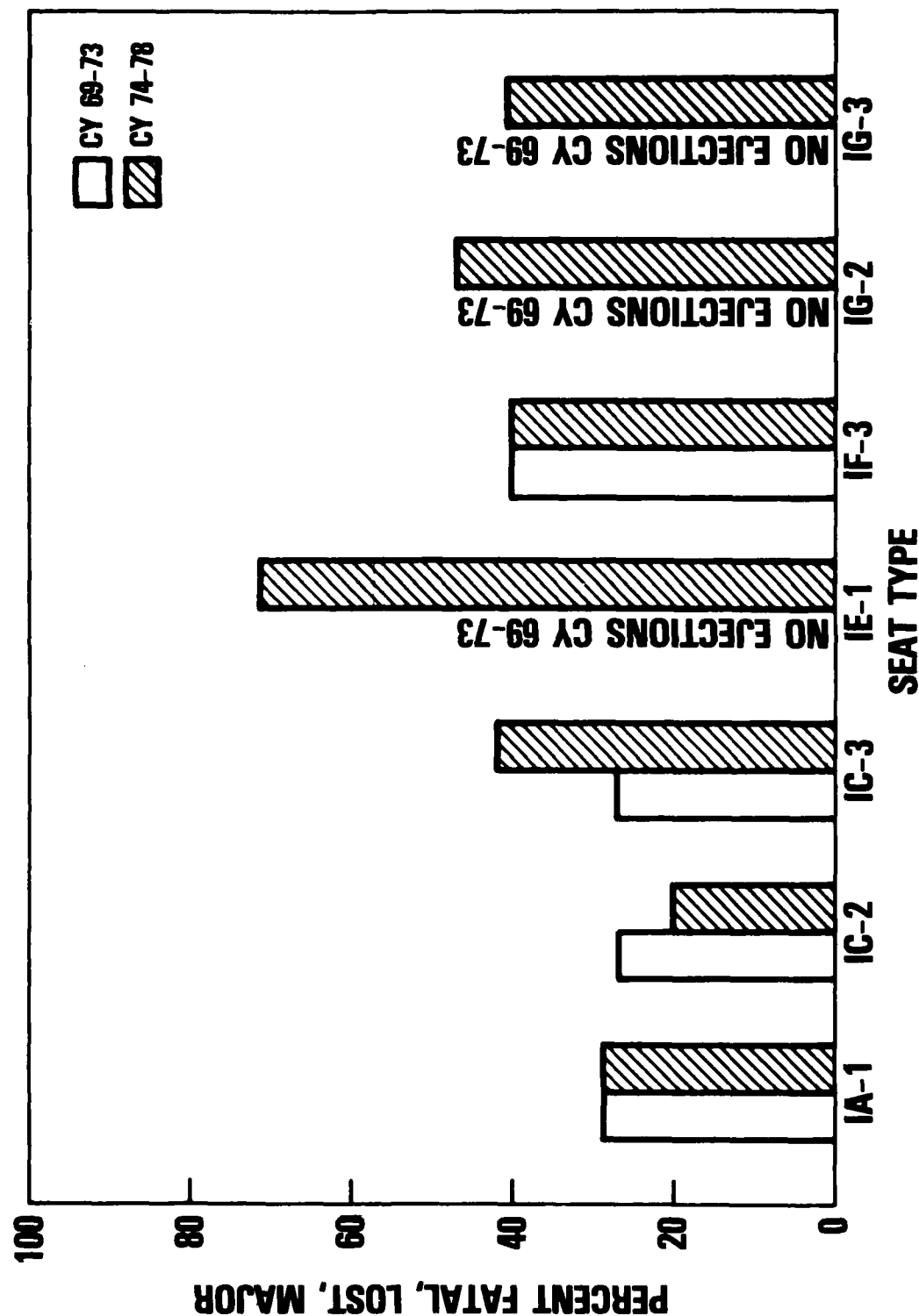


DATES: 73-78

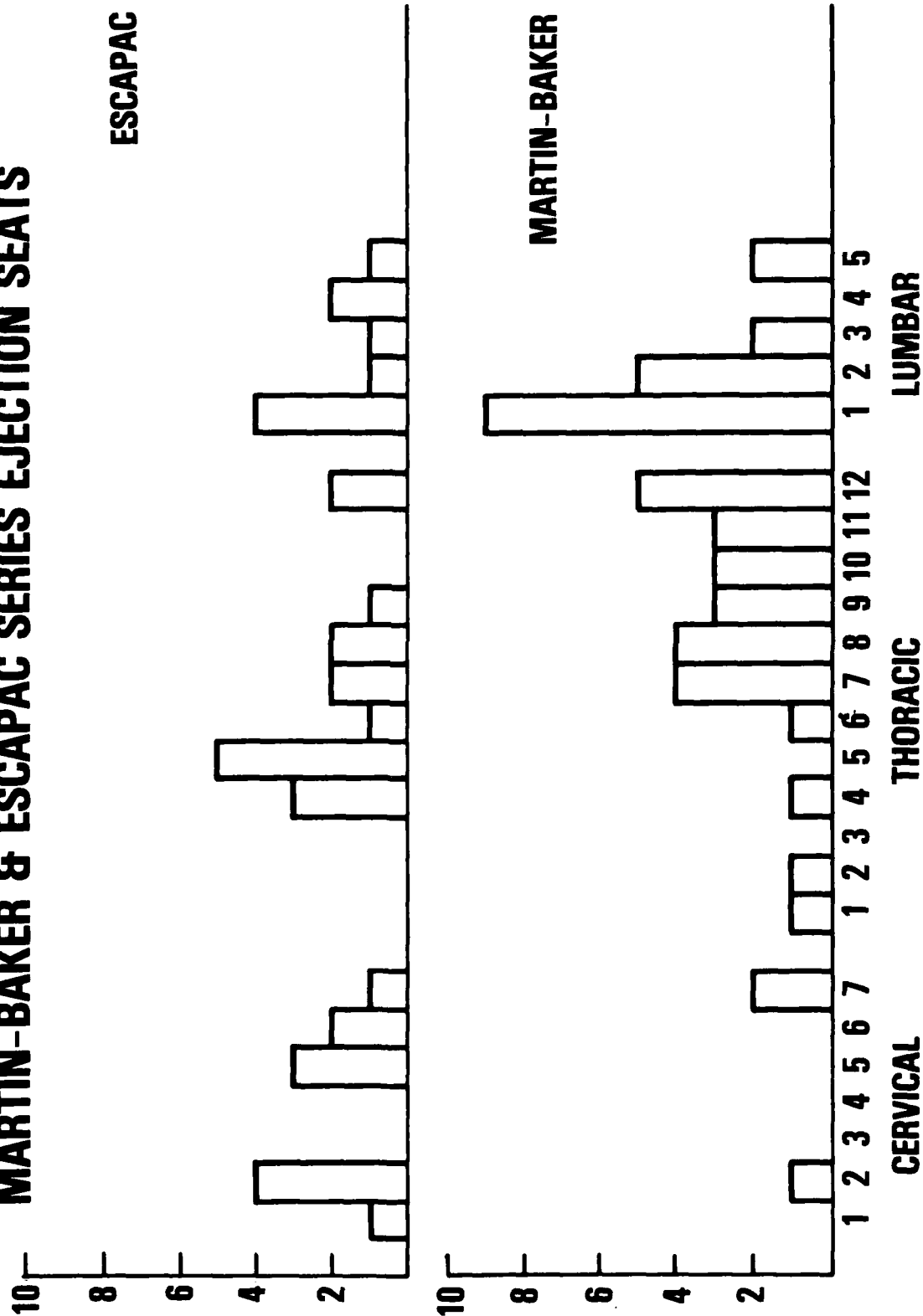
COMPARISON OF FATAL AND LOST INJURIES BY ESCAPAC SEATS CY 69-73 VS CY 74-78



COMPARISON OF FATAL, LOST, MAJOR INJURIES BY ESCAPAC SEAT TYPE CY 69-73 VS CY 74-78

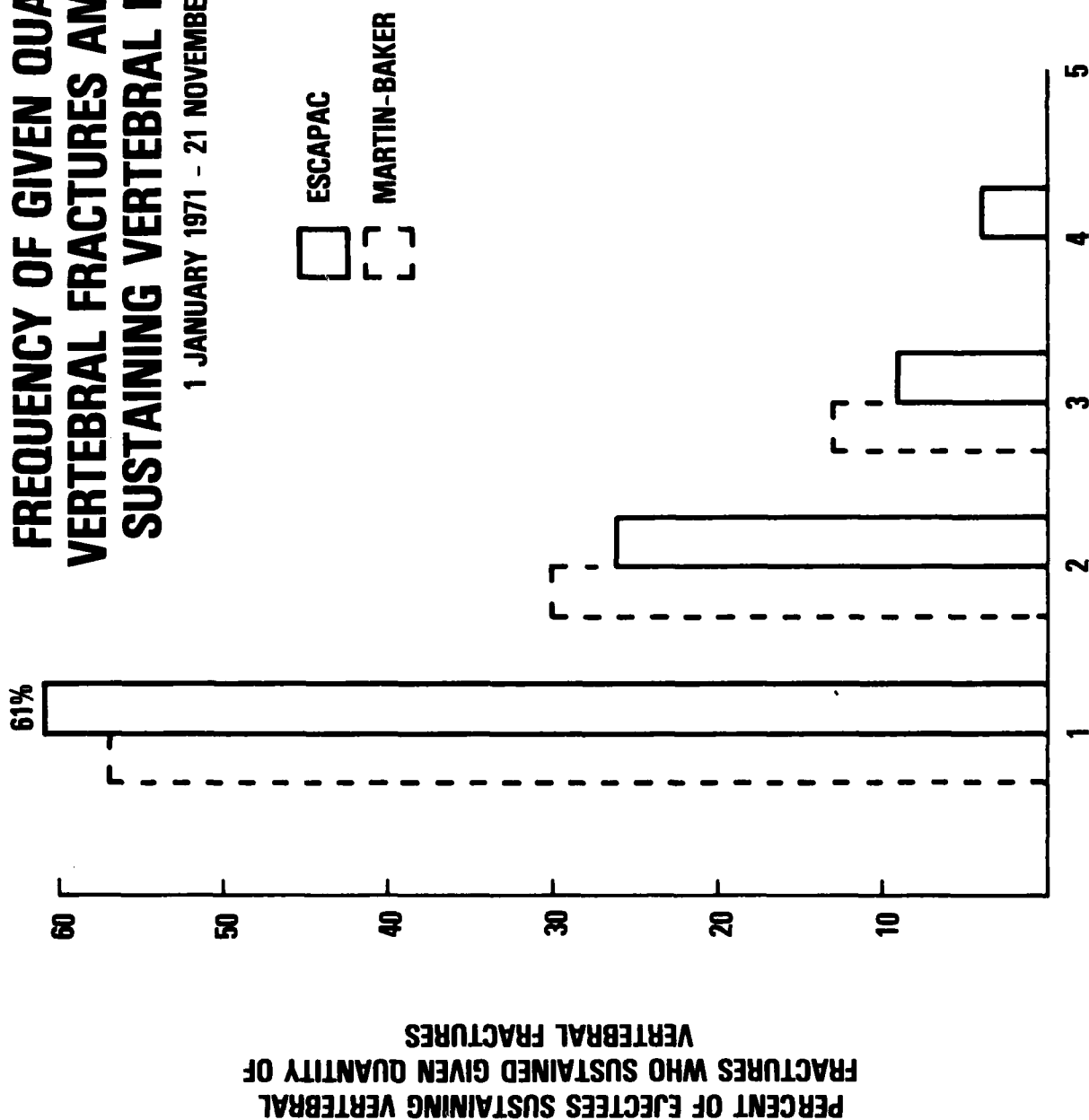


VERTEBRAL FRACTURE DISTRIBUTION AMONG USN EJECTEES 1 JANUARY 1971 - 21 NOVEMBER 1978 MARTIN-BAKER & ESCAPAC SERIES EJECTION SEATS



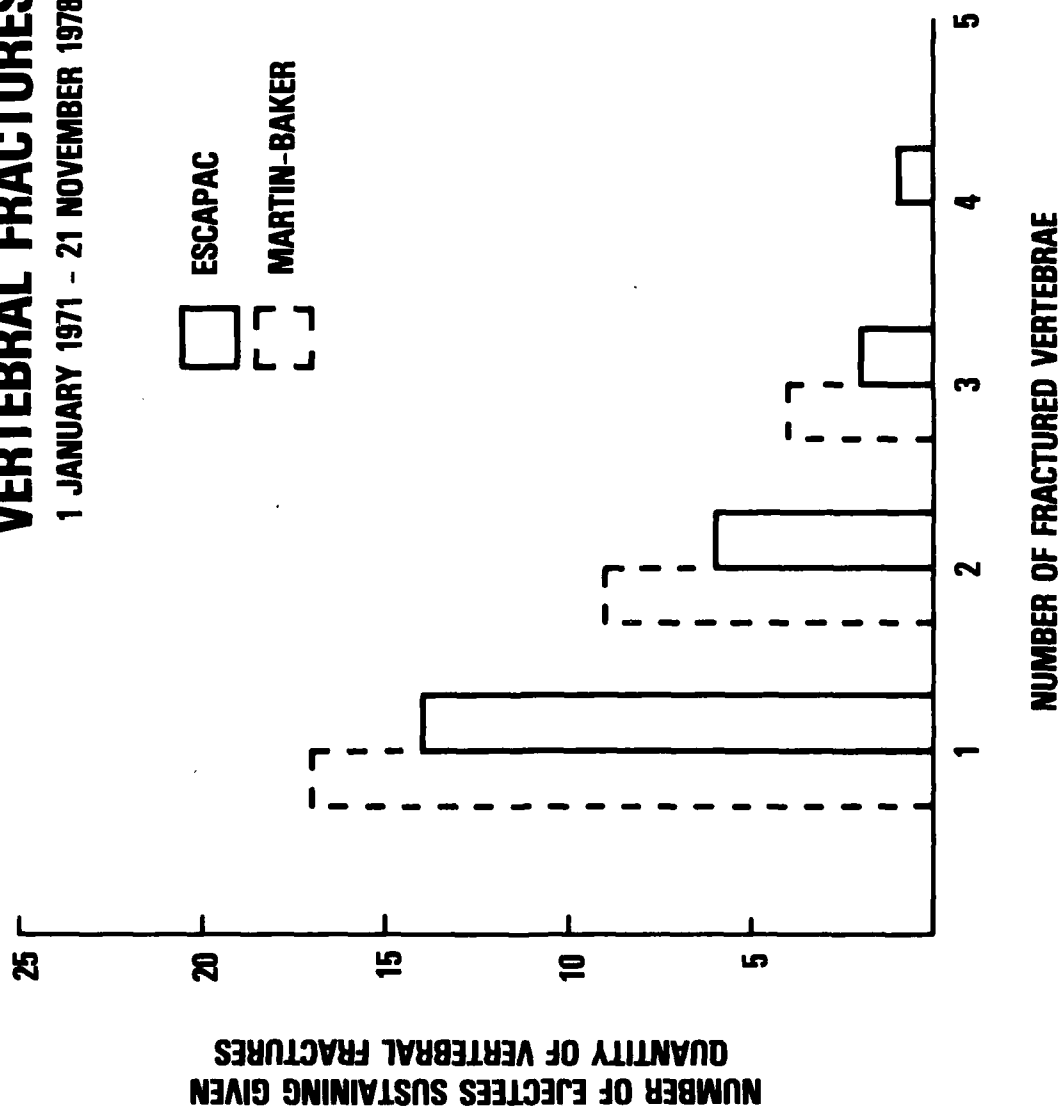
FREQUENCY OF GIVEN QUANTITIES OF VERTEBRAL FRACTURES AMONG THOSE SUSTAINING VERTEBRAL FRACTURES

1 JANUARY 1971 - 21 NOVEMBER 1978



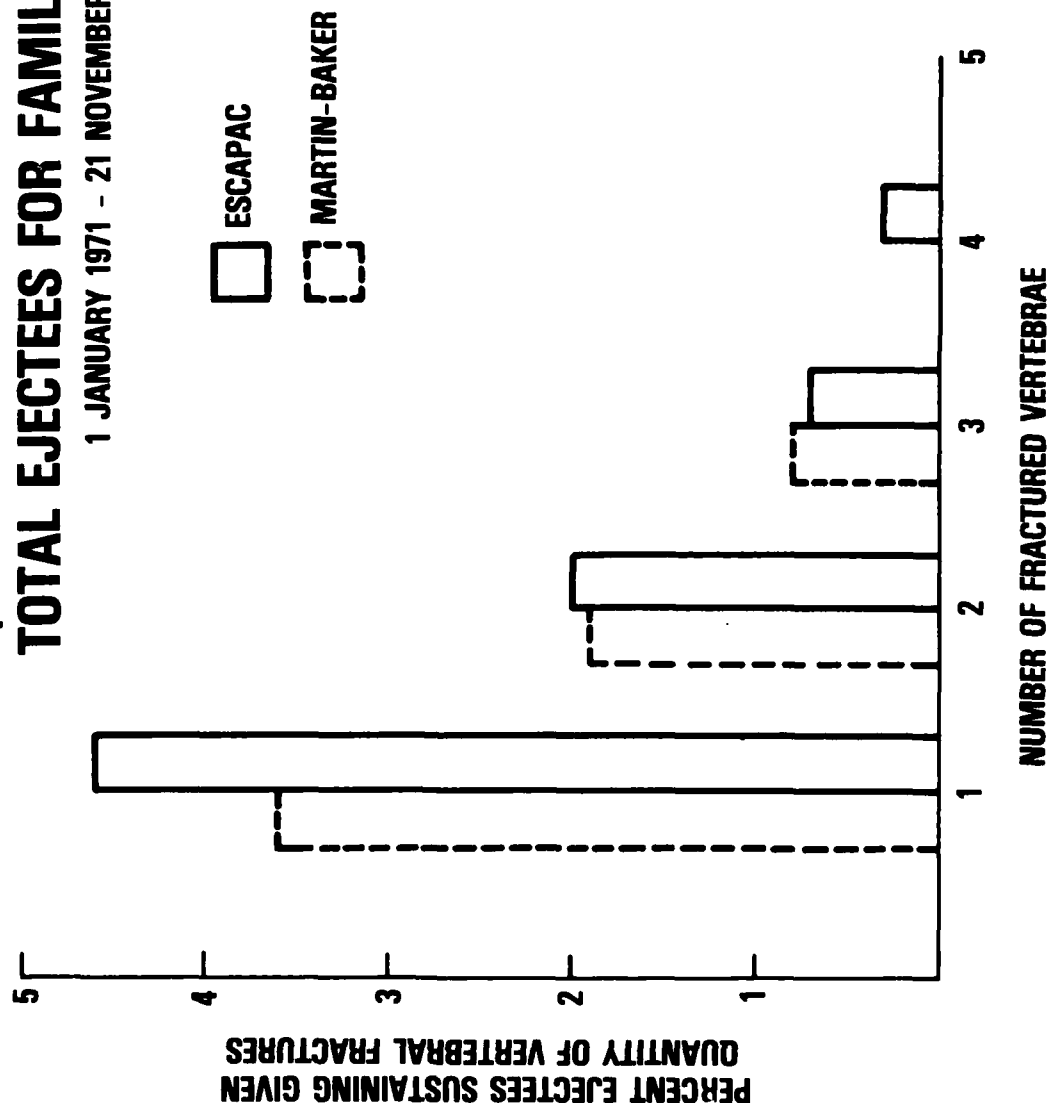
NUMBER OF VERTEBRAL FRACTURES PER EJECTEE SUSTAINING ONE OR MORE VERTEBRAL FRACTURES

1 JANUARY 1971 - 21 NOVEMBER 1978



NUMBER OF VERTEBRAL FRACTURES PER EJECTEE SUSTAINING ONE OR MORE VERTEBRAL FRACTURES (EJECTEES EXPRESSED AS PERCENT OF TOTAL EJECTEES FOR FAMILY OF SEATS)

1 JANUARY 1971 - 21 NOVEMBER 1978



MOR (MARTIN-BAKER) INJURY DATA
1 JANUARY 1969 THRU 31 DECEMBER 1978

NUMBER OF INJURIES BY AIRCRAFT

INJURY TYPE	A-6	F-4	F-8	F-9	F-14	T-1	AV-8A	TOTALS
MINOR/ MINIMAL/NONE	81	264	91	15	40	2	4	497
MAJOR	34	35	7	14	7	2	3	102
FATAL	16	36	6	4	10	2	1	75
LOST	11	25	4	1	1	0	0	42
TOTALS	142	360	108	34	58	6	8	716

MOR (MARTIN-BAKER) INJURY DATA
1 JANUARY 1969 THRU 31 DECEMBER 1973
NUMBER OF INJURIES BY AIRCRAFT MODEL

INJURY TYPE	A-6	F-4	F-8	F-9	F-14	T-1	AV-8A	TOTALS
MIN/NONE	47	188	76	15	2	2	0	330
MAJOR	19	28	6	14	0	2	1	70
FATAL	12	21	6	4	0	2	0	45
LOST	3	14	4	1	0	0	0	22
	—	—	—	—	—	—	—	—
TOTALS	81	251	92	34	2	6	1	467

MOR (MARTIN-BAKER) INJURY DATA
1 JANUARY 1974 THRU 30 JUNE 1978
NUMBER OF INJURIES BY AIRCRAFT MODEL

INJURY TYPE	A-6	F-4	F-8	F-9	F-14	T-1	AV-8A	TOTALS
MINIMAL/MINOR/NONE	28	72	15	0	32	0	4	151
MAJOR	15	7	1	0	7	0	2	32
FATAL	3	15	0	0	10	0	1	29
LOST	6	11	0	0	1	0	0	18
	—	—	—	—	—	—	—	—
TOTALS	52	105	16	0	50	0	7	230

MARTIN-BAKER EJECTIONS BY SEAT TYPE NUMBER AND PERCENT OF INJURIES BY INJURY CLASSIFICATION

1 JANUARY 1969 THRU 31 DECEMBER 1978

SEAT TYPES	FATAL	%	LOST	%	MAJOR	%	MINOR	%	MINIMAL NONE	%	TOTALS	%
A 5	4	5	1	2	8	8	3	2	3	0.9	19	3
A 7	0	0	0	0	5	5	1	1	2	0.6	8	1
F 5	2	3	2	5	1	1	5	3	7	2	17	2
F 7	4	5	2	5	6	6	16	9	63	19	91	13
GRU 5	13	17	4	10	23	22	32	19	18	5	90	13
GRU 7	3	4	4	10	7	7	11	6	10	3	35	5
GRU 7A	10	13	1	2	7	7	11	6	27	8	56	8
GRUEA 7	0	0	3	7	4	4	7	4	5	2	19	2
H 5	0	0	1	2	3	3	5	3	4	1	13	2
H 7	36	48	24	57	32	31	76	44	179	55	347	48
TYPE-9	1	1	0	0	3	3	2	1	2	0.6	8	1
L 5	2	3	0	0	2	2	1	1	1	0.3	6	0.8
Z 5	0	0	0	0	1	1	1	1	5	2	7	0.9
TOTALS	75		42		102		171		326		716	

MARTIN-BAKER EJECTIONS BY INJURY CLASSIFICATION AND SEAT TYPE

1 JANUARY 1969 THRU 31 DECEMBER 1973

(INJURY BY SEAT TYPE)

INJURY TYPE	A 5	A 7	F 5	F 7	GRU 5	GRU 7	GRU 7A	H 5	H 7	TYPE-9	L 5	Z 5	TOTALS
MINIMAL/NONE	3	2	7	48	16	2	1	4	117	0	1	5	206
MINOR	3	1	5	16	29	0	1	5	62	0	1	1	124
MAJOR	8	5	1	5	18	1	0	3	25	1	2	1	70
FATAL	4	0	2	4	10	2	0	0	21	0	2	0	45
LOST	1	0	2	2	3	0	0	1	13	0	0	0	22
TOTALS	19	8	17	75	76	5	2	13	238	1	6	7	467

AD-A171 659

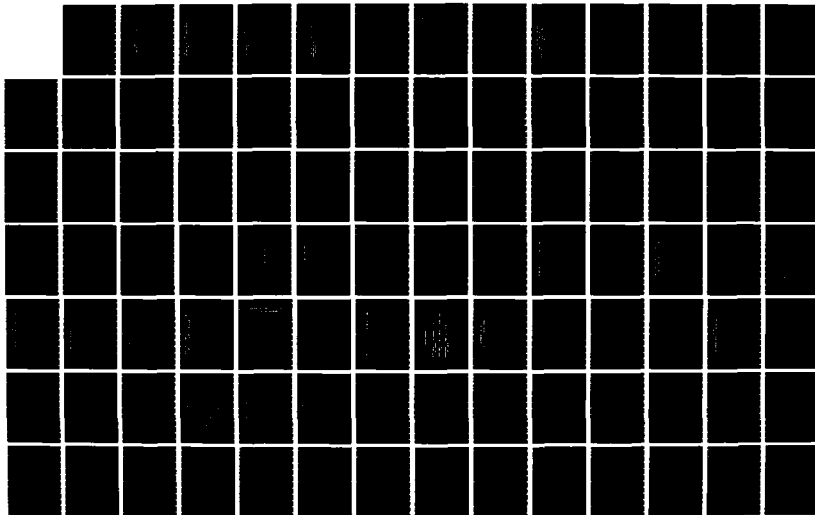
AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS
PROGRAM SYMPOSIUM H. (U) NAVAL SAFETY CENTER NORFOLK VA
1981

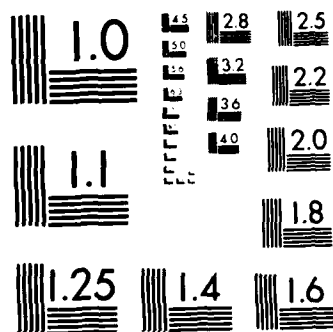
3/4

UNCLASSIFIED

F/G 1/3

ML





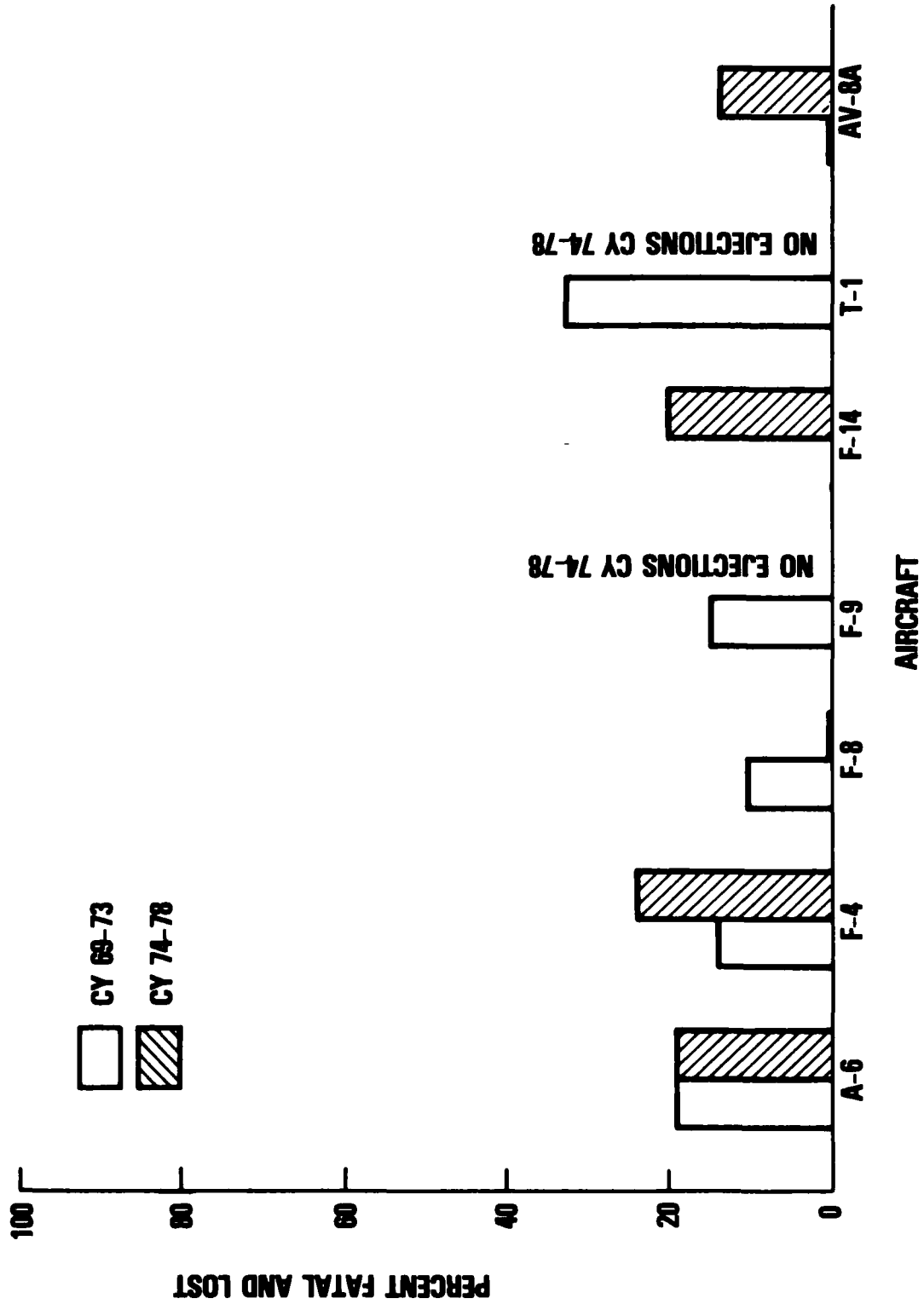
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

MARTIN-BAKER NUMBER OF INJURIES BY SEAT TYPE AND INJURY CLASSIFICATION

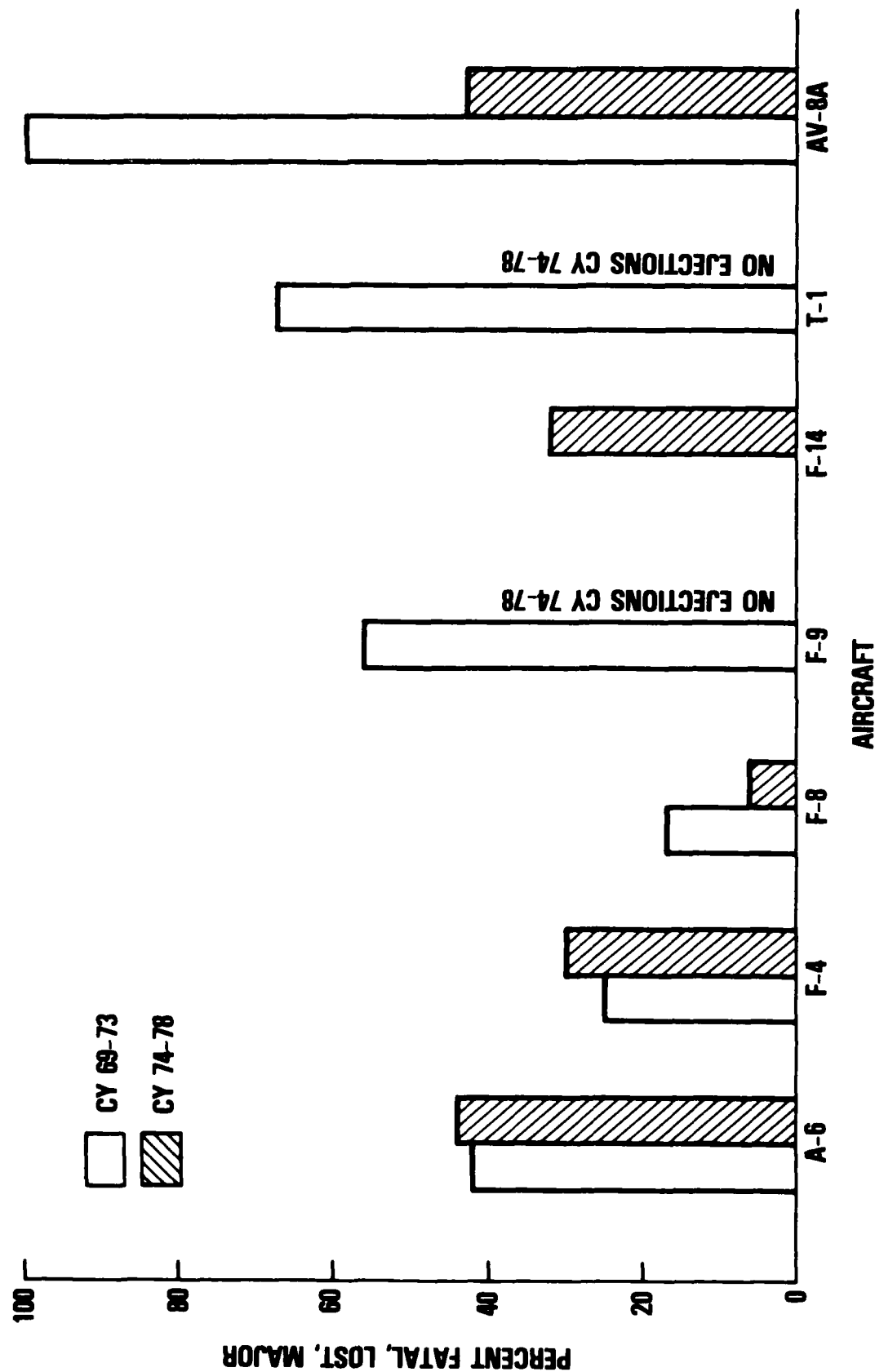
1 JANUARY 1974 THRU 30 JUNE 1978

INJURY TYPE	F 7	GRU 5	GRU 7	GRUEA 7	GRU 7A	H 7	TYPE-9	TOTALS
MINIMAL/NONE	15	2	5	5	22	58	2	109
MINOR	0	3	10	3	10	14	2	42
MAJOR	1	5	6	4	7	7	2	32
FATAL	0	3	0	0	10	15	1	29
LOST	0	1	4	1	1	11	0	18
TOTALS	16	14	25	13	50	105	7	230

PERCENTAGES OF FATAL AND LOST INJURIES RESULTING FROM MARTIN-BAKER EJECTIONS BETWEEN CY 69-73 AND CY 74-78 (BY AIRCRAFT)



PERCENTAGES OF FATAL, LOST, MAJOR INJURIES RESULTING FROM MARTIN-BAKER EJECTIONS BETWEEN CY 69-73 AND CY 74-78 (BY AIRCRAFT)



INCIDENCE OF VERTEBRAL FRACTURES AMONG MARTIN-BAKER & ESCAPAC EJECTEES COMPARISON OF VERTEBRAL FRACTURES

	TOTAL EJECTEES	EJECTEES W/ VERTEBRAL FRACTURES	VERTEBRAL FRACTURE RATE
ESCAPAC	305	23	8%
MARTIN-BAKER	471	30	6%

PERIOD: 1 JANUARY 1971 - 21 NOVEMBER 1978

USN ESCAPAC SEAT DATA BY AIRCRAFT TYPE

1 JANUARY 1974 THRU 30 JUNE 1978

NUMBER INJURIES BY AIRCRAFT MODEL

INJURY TYPE	A-4	A-7	S-3	TOTALS
MIN/NONE	49	37	2	88
MAJOR	12	10	0	22
FATAL	12	7	3	22
LOST	5	3	0	8
TOTALS	78	57	5	140

ESCAPAC SEAT INJURY CLASSIFICATION BREAKOUT BY SEAT TYPE

1 JANUARY 1974 THRU 30 JUNE 1978

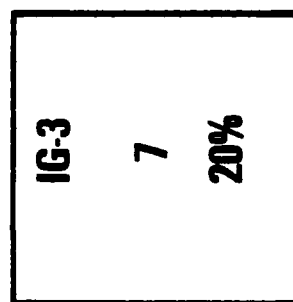
TYPE INJURY	PRE SEAT-MAN ROCKET			SEAT-MAN SEPARATOR ROCKET			
	IA-1	IC-3	IC-2	IE-1	IF-3	IG-2	IG-3
MAJOR	1	3	5	0	2	5	6
FATAL	4	3	0	3	3	7	2
LOST	0	2	0	0	1	3	2
MIN/NONE	12	11	20	2	9	17	17
TOTALS	17	19	25	5	15	32	27

SUMMARY:

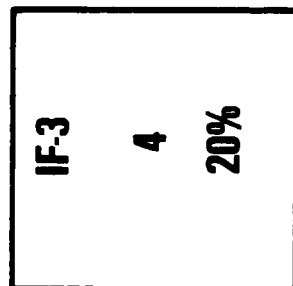
TYPE INJURY	NUMBER OF INJURIES		NUMBER OF INJURIES	
	IA-1, IC-3, IC-2		IE-1, IF-3, IG-2, IG-3	
MAJOR	9	(15%)	13	(16%)
FATAL	7	(11%)	15	(19%)
LOST	2	(3%)	6	(7%)
MIN/NONE	43	(71%)	45	(58%)
TOTALS	61		79	
F+L		15%		27%
F+L+M		30%		43%

ESCAPAC MAJOR INJURIES

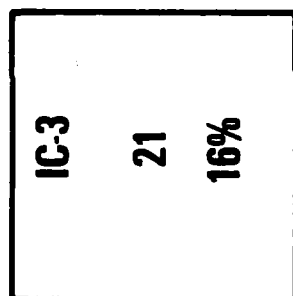
COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS



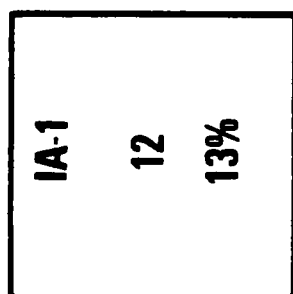
DATES: 74-78



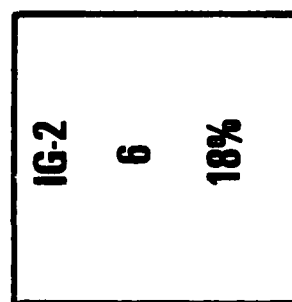
DATES: 72-77



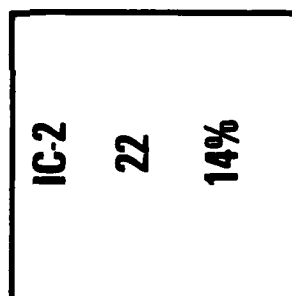
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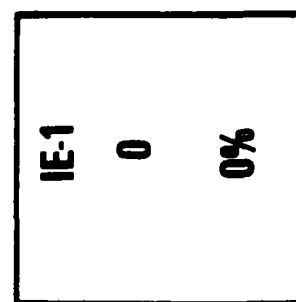
DATES: 69-78



DATES: 75-78



DATES: 69-76



DATES: 73-78

A-4

A-7

S-3

ESCAPAC MAJOR INJURIES **COMPARATIVE INCIDENCE RATES** **AMONG SURVIVORS & NON-LOST/IMPACT MULTIPLE** **EXTREME FATALITIES**

A-4

IA-1
12
15%

DATES: 69-78

IC-3
21
19%

DATES: 64-77

IF-3
4
21%

DATES: 72-77

IG-3
7
23%

DATES: 74-78

A-7

IC-2
22
15%

DATES: 69-76

IG-2
6
21%

DATES: 75-78

S-3

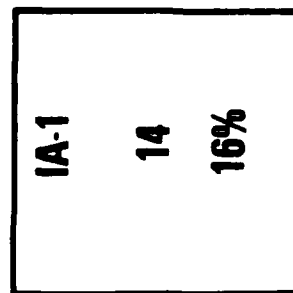
IE-1
0
0%

DATES: 73-78

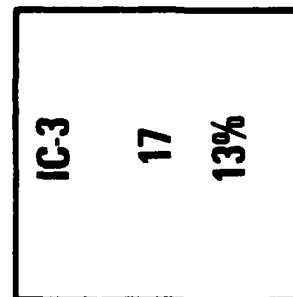
ESCAPAC FATAL/LOST INJURIES

COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS

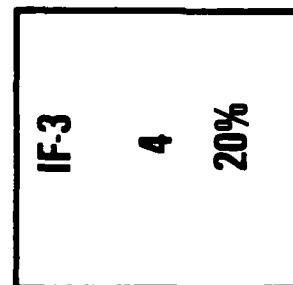
A-4



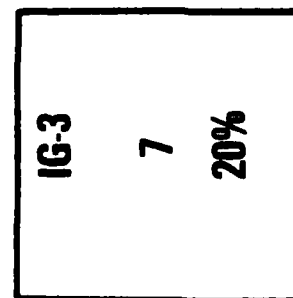
DATES: 69-78



DATES: 69-77

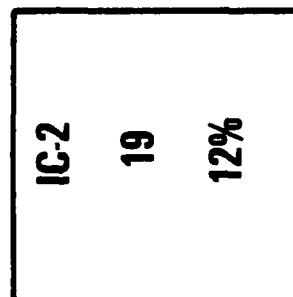


DATES: 72-77

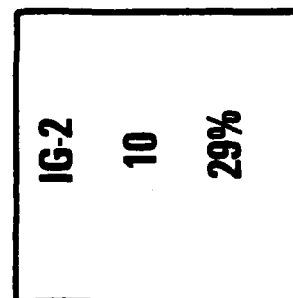


DATES: 74-78

A-7

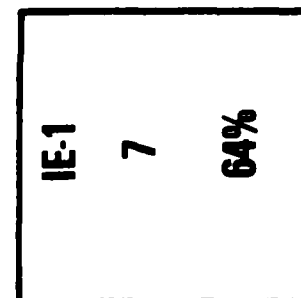


DATES: 69-76



DATES: 75-78

S-3



DATES: 73-78

ESCAPAC FATAL/LOST & MAJOR INJURIES

COMPARATIVE INCIDENCE RATES AMONG ALL ESCAPE ATTEMPTS

A-4	<div>IA-1 26 29%</div> <div>DATES: 69-78</div>	<div>IC-3 38 29%</div> <div>DATES: 69-77</div>	<div>IF-3 8 40%</div> <div>DATES: 72-77</div>	<div>IG-3 14 40%</div> <div>DATES: 74-78</div>
		<div>IC-2 41 26%</div> <div>DATES: 69-76</div>		<div>IG-2 16 47%</div> <div>DATES: 75-78</div>
				<div>IE-1 7 64%</div> <div>DATES: 73-78</div>
A-7				
S-3				

SYNOPSIS A-7 FATALITIES^{a)}

1974 - 1978

<u>CATEGORY</u>	<u>NUMBER</u>
o Fireball involvement	1
o Seat failed, ejection in envelope	1 ^{b)}
o Ejection out of envelope	2 ^{c)}
o Good parachute, did not survive in water	6 ^{d)}

NOTES

- (a) All ejections were with ESCAPAC IG-2
- (b) Pilot impacted water in seat although apex of trajectory estimated to be 150'. Subsequent investigation of recovered seat revealed man-seat separation not initiated due to failure of cartridge on MK 16 Mod 0 rocket catapult.
- (c) One pilot struck ground at approximately full riser stretch. Pilot had previously stated intent to attempt save and aircraft, did not want aircraft loss on record. Other pilot impacted ground approximately 10 feet from seat and 50 yards from aircraft impact crater.
- (d) Among those entering water:
 - (1) Ejection following night ramp strike. Full parachute seen and ejectee then struggling in water. Suffered contusions on face and abrasions on neck (latter from suspension lines). Drowned.
 - (2) Ejection following night ramp strike. Full parachute seen, ejectee not seen even by swimmer at parachute. Lost.
 - (3) Parachute observed by wingman streaming as man (seat) entered undercast. Helmet recovered bearing evidence of high speed escape and severe blow to back of helmet/head from Koch fittings. Lost.
 - (4) Wingman observed fully deployed parachute for period of 1 minute 50 seconds before water contact. Did not report seeing ejectee. Lost.

A-7 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7E	200' (duration of beeper signal)	UNK	UNK	ESCAPAC 1G-2	Multiple extreme, impact with ground.	Fireball destroyed parachute and shroud lines.
A-7E	65'	60	Sliding down deck, R wing low	ESCAPAC 1G-2 TC	Pulmonary edema - drowning. Contusions on face - canopy. Abrasions on neck - suspension lines. Entanglement caused drowning.	Night ejection from carrier deck. Seen struggling in water. LPA initiated. Full parachute seen.
A-7A	75'	80	Slight nose 5° down, L wing down 20-30° sliding off carrier deck	ESCAPAC 1G-2 TC	Lost	Night ejection from carrier deck, full parachute seen. Ejectee lost. Flew with seat full up--may have affected breaker operation.
A-7B	2,500-4,500	UNK	70° nose down uncontrolled flight	ESCAPAC 1G-2 TC	Lost. Investigation of damage to recovered helmet suggested high speed escape and severe blow to helmet/head from Koch fittings.	Helmet struck by Koch fittings - helmet shell fractured. Wingman reported seeing streaming parachute prior to seat-man entering clouds.
A-7A	below 65	120	~ flat	ESCAPAC 1G-2	Recovered seat revealed cartridge of MK 16 ROCKET failed.	Cold cat shot, subsequent ejection. Ejection trajectory reached 150'. No man-seat separation. Seat in a high position.

A-7 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7E	UNK	400 (est)	UNK	ESCAPAC 1G-2 TC	Lost	Wingman saw parachute fully deployed above clouds at 1500-2000'. Did not observe ejectee. Visual observation of parachute for 1 min. 50 secs. before water contact.
A-7E	300-400'	135-175	20-30° R wing down, nose level or slightly elevated	ESCAPAC 1G-2 TC	Drowning. Temporal bone hemorrhage, bilateral contusions R & L superior and anterior shoulders, R & L lateral and anterior upper arms and both groins.	Full parachute observed. Pilot was weak when approached by swimmer 1 min. 37 secs. after ejection; made little effort to help himself.
A-7E	6200-7200 MSL 1000-2000 AGL	250-350	90° nose down	ESCAPAC 1G-2 TC	Multiple extreme impact on ground. Had previously indicated intent to not lose aircraft.	Pilot struck ground just prior to full riser stretch. Unauthorized maneuver, departed controlled flight.
A-7E	10	120	Wings level descending slightly nose up. Cold cat shot.	ESCAPAC 1G-2 TC	Drowning. Multiple contusions upper paravertebral area. Contusion in R periorbital region of face. Subgaleal hemorrhage in R parietal area. Surgeon stated if not injured in ejection, would have survived.	Full parachute observed after tumbling, gave thumbs up signal. Inflated LPA, R not inflated. Passed within 10' of hull, then into wake.
A-7E	1100	200		ESCAPAC 1G-2 TC	Multiple extreme impact with ground.	Body recovered 20' from seat, hip recovered later 10' from body. Body was approximately 50 yds. from A/C impact crater.

SYNOPSIS A-4 FATALITIES

1974 - 1978

<u>CATEGORY</u>	<u>NUMBER</u>
● Ejection during aircraft breakups	1 a)
● Fireball involvement	1 b)
● Drowning/Lost ^{c)}	3 d)
● Seat failed after ejection	2 e)
● Attempted ejection in envelope	6 f)
- Canopy jettisoned, seat stayed	4 f)
- Canopy did not jettison	2 g)
● Attempted ejection outside envelope	4 h)
- Canopy jettisoned, seat stayed	1
- Seat ejected	3 h)

NOTES

- (a) ESCAPAC IC-3 Good parachute seen, no sign of life, ejectee LOST so no determination of injury cause.
- (b) ESCAPAC IA-1 Shorter trajectory and timing of new seats might have prevented entry into fireball.
- (c) One recorded as lost -- insufficient data for placement into any other category, although good parachute was seen (See (d)).
- (d) ESCAPAC IG-3 Wingman saw two good parachutes (ejected from 2-seat TA-4F) no commentary on whether signs of life was present. Ejection was over water, ejectee LOST.
- ESCAPAC IF-3 Ejectee drowned. However ejectee suffered fracture dislocation at C-5/C-6. Such injury capable of immobilizing individual and, with one exception, has proven fatal to ejectees descending onto land.
- (e) ESCAPAC IF-3 Parachute did not deploy. Evidence suggests emergency release handle had released end of parachute pack actuator arming cable.

- ESCAPAC IF-3 Parachute entangled with contents of survival kit which opened during or following man-seat separation.
- (f) ESCAPAC IC-3(2) Four cases in A-4F, 1 A-4L, and TA-4J,
 ESCAPAC IG-3(1) Attempts, as evidenced by canopy jettisoning, were
 ESCAPACIAA1(1) well within seat envelope. Known that their air-
 crew attempted to eject, not known concerning fourth
 (student in TA-4J).
- (g) NOT SPECIFIED Two cases in TA-4J. One cause not determined (air-
 ESCAPAC IG-3 craft lost). Other due to misinstallation/misrig-
 ging MK 73 initiator in canopy jettisoning system.
 Both attempts apparently made within seat envelope.
- (h) ESCAPAC IA-1 Ejectee impacted water just at or immediately prior
 to full riser stretch. Shorter trajectory and timing
 of new seats might have slowed ejectee sufficiently
 for his survival.

A-4 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-4M	68,000	+500 KIAS	90° Dive	ESCAPAC IC-3	Lost	Ejection during aircraft breakup observed under chute -- no life observed.
TA-4J	270±50	.90-.92 Mach 500+ KIAS	80° dive	ESCAPAC IG-3	Multiple extreme. (recovered tissue samples)	Unsuccessful ejection attempt at 270±50 followed by aircraft ground impact.
A-4C	95 Parachute opening at 135	140-145	10° nose down wings level	ESCAPAC IA-1	Posterior ribs (R 3 & 5, L 4-10) fractured. Transverse fracture T4 & T5. Compression fracture L2. Fracture/dislocation pelvis. Skin burns 3rd, 4th & 5th degree & 2nd various areas. Laceration of R & L atria & R ventricle of heart. Posterior lacerations of R lung. Homothorax of L lung. Laceration & hemo-pericardium. Diaphragm lacerations.	Internal injuries due to impact with ground - parachute disintegrated in crash fireball.
TA-4J	0 (harness release handle had been releasing parachute actuation arm cable. This ejectee used face curtain.)	30 KTS	Level	ESCAPAC IF-3	Fracture right rib cage. Interstitial hemorrhage right lung. Intraventricular hemorrhage cerebral ventricles. Peri-vertebral hemorrhage. Fracture left humerus. Fracture right scapula. Fracture cricoid cartilage & 1st tracheal ring.	No parachute, impacted ground.
					No injury.	Seat worked normally.

A-4 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
NA-4E	500	150-200	Sharply nose down. L wing down spiraling.	ESCAPAC IA-1	Multiple massive injuries due to high velocity impact with surface.	Impact before full line stretch t>2 sec
TA-4J	3,000				Lost	Pilot transmitted. He could not eject -- canopy did not jettison.
A-4M	10,000	UNK		ESCAPAC IF-3	Fracture of skull, basilar fracture, occipital rim fracture, temporal & parietal subluxation C-4, spinous processes fracture C1, C2, C3, C4. Fracture multiple ribs. Fracture of ischium & pubic ramus. Comminuted fracture L femur.	Impact with surface. Parachute entangled in life raft lanyard deployed due to survival kit failure.
TA-4F	1800 (dragged by chute)	180	10° nose up	ESCAPAC IC-3	Pulmonary congestion R & L lungs. Hemorrhage R & L middle ears. Small contusion middle forehead, small contusion bridge of nose (believed not to have caused unconsciousness)	
	(dragged by chute)				Small laceration of upper lip.	Due to survival kit strap unable to open it. Began to drag him under. Ejected by sequence while bent over.
TA-4J	UNK	UNK	UNK	ESCAPAC IC-3	Lost	Evidence of ejectee being in seat at water impact.

A-4 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-4F	5000	250	Level	ESCAPAC IG-3		Canopy jettisoned - several attempts at ejection followed by attempted bailout. Impacted water in aircraft
TA-4J	4000	180		ESCAPAC IC-3	Multiple extreme a/c impact w/ground.	Canopy jettisoned. Instruction used face curtain. Student apparently made no attempt.
					Multiple extreme a/c impact w/ground.	
TA-4J				ESCAPAC IG-3	a/c impact w/water. Drowning (managed to release 2 upper kochs & lower R mini-koch)	Attempted ejection - canopy did not jettison. MK 73 did not fire on canopy remover.
TA-4J	1500 2 good parachutes seen	250	Wings level	ESCAPAC IF-3	Mild paravertebral & pectoral muscle strain.	Parachute suspension lines & URT-33 lanyard tangled - evidence of tumbling.
					Drowned. Fracture - dislocation C5-C6.	
A-4E	200	125	60° nose down 130-150° R wing down	ESCAPAC IA-1	Multiple extreme impact w/water.	Pilot impacted water just after seat-man separation.

A-4 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
TA-4J	UNK	UNK	70-90° nose down	ESCAPAC IG-3	Lost	
A-4L	1000-1800 AGL			ESCAPAC 1A-1	Multiple extreme impact w/ground in aircraft following ejection seat failure to fire.	Pilot pulled both controls, canopy jettisoned, but seat did not eject. Primer of rocket catapult did not fire after firing pin struck.

SYNOPSIS S-3 FATALITIES^{a)}

1974 - 1978

<u>CATEGORY</u>	<u>NUMBER</u>
o Ejection seat failed	1 ^{b)}
o Ejection initiated outside envelope	2 ^{c)}

NOTES

- (a) All S-3A ejections used ESCAPAC IE-1.
- (b) TACO seat-man separation cartridge did not ignite (primer fired). In addition empty SENSO seat propulsion inflicted various 3rd degree burns on TACO. (Pilot and co-pilot ejected successfully).
- (c) Empty TACO and SENSO seats cleared aircraft approximately 25', lefthand seat completed ejection sequence although ejectee was killed while egressing from aircraft as it disintegrated upon ground impact, right-hand seat upward travel was stopped by aircraft disintegration at ground impact.

S-3 FATALITIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	TYPE SEAT	INJURY DESCRIPTION	EJECTION DESCRIPTION
S-3A	25 rear seats at impact front seats	UNK (stalled)	R wing down	ESCAPAC IE-1 TC	R multiple extreme in disintegration of a/c upon impact w/ ground. L multiple extreme due to contact w/disintegrating cockpit structure during ejection at aircraft impact.	R seat stopped by R wing down crash. L seat ejected, ejectee killed in crash, full parachute obtained.
S-3A	0	20-40 knots rolling on ground leaving runway		ESCAPAC IE-1 TC	R 1st degree burns L & R legs anterior surfaces. Contusions on buttocks. L 1st, 2nd degree burns left leg posterior surface 1st degree burns right leg posterior surface. TACO: Multiple fractures and soft tissue injuries at ground impact. 3rd degree burns left hand, forearm & left posterior neck.	No man-seat separation, received burns from ejected empty seat rocket. Cartridge failed to fire.

SYNOPSIS A-7 MAJOR INJURIES

1974 - 1978

<u>CATEGORIES</u>	<u>NUMBER</u>
o <u>SYSTEM FAILURES</u>	1
- Ejection initiated by windblast through failed canopy glass	1 ^a
o <u>INJURIES</u>	
- Vertebral	
- Cervical	
- Subluxation/fracture-dislocation	1 ^b
- Fracture	-
- Strain/muscle spasm	4
- Thoracic	
- Fracture	3
- Lumbar	
- Fracture	2
- Noncervical paravertebral strain	1
- Joints	
- Shoulder dislocation	-
- Shoulder fractures	-
- Elbow fractures	-
- Knee ligamental strains	1
- Knee derangement	1 ^c
- Limbs	
- Arm fractures	-
- Leg fractures	3 ^{b) d)}
- Chest	
- Rib fractures	-
- Dislocations	-
- Burns	-
- Brain concussion	-
- Unconsciousness	-

NOTES

- (a) ESCAPAC IC-2 Face curtain failed under windblast loads causing ejection. Retention under windblast loads is a design requirement.
- (b) ESCAPAC IG-2 Ejectee felt intense pain in neck during boost period. Unable to look at landing area and broke leg landing on rock slide. During survival phase ejectee was in intense pain -- had to kneel and force head into ground to obtain relief.
- (c) ESCAPAC IC-2 Internal derangement of knee occurred prior to landing believed caused by tumbling and resulting flailing. Injury required surgery to correct.
- (d) ESCAPAC IC-2 Survival kit hanging very low interfered with legs contributing to several fractures in left leg during parachute landing.
- ESCAPAC IG-2 Sustained severe strain during boost phase subsequently inhibiting ejectee's ability to examine landing area. Broke left leg when left foot landed between rocks or roots.

A-7 MAJOR INJURIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7B	1,500	200 (tumbling noted -- landed in water)	Nose up	ESCAPAC IC-2	B Cervical strain. Contusion on R hand. (hand on stick when ejection initiated using L hand.)	Following flame out, pilot ejected using lower firing control. Felt his hand snap hard to left. Struggling w/kit before getting it open.
A-7B	25,000 est.	270 est.	25° Nose down wings level	ESCAPAC IC-2	B Soft tissue injury R elbow. Burn left hand. Muscle spasm cervical. Possible fracture L-4 (discounted in MOR)	Canopy glass failed at 30,000 ft. While descending pilot was ejected -25,000 ft. by windblast.
A-7B	1,100 (tumbling noted)	194	Nose up slightly 10° wings level	ESCAPAC IC-2	B Internal derangement of R knee (required surgery). Low-thoracic backstrain.	Used lower control to initiate ejection. Head slightly bent forward as seat was full up.
A-7E	12,000	400 KIAS	Nose down 60° Left bank 90°	ESCAPAC IC-2	B Subconjunctival hemorrhage and periorbital ecchymosis of eyes. Abrasions anterior tibia. Abrasions L shoulder.	Pilot was against the canopy in a spin, managed to pull lower handle w/3 fingers L hand. Eyes were swollen shut and was unable to see.
A-7E	12,000	375	Nose down 10° R bank 135°	ESCAPAC IC-2	B Burned eyebrows soft tissue injury R knee. Soft tissue injury L wrist.	Used face curtain to eject a/c on fire.
A-7C	100-200 (experienced back pain during egress)	145	Nose down 5° wings level descending	ESCAPAC IC-2	B Oblique fracture L distal tibia and fibula and proximal fibula. Compression fracture L1. Abrasions, ecchymosis R & L shoulders.	Used alternate firing control following take off flameout. Survival kit hung low and helped produce broken L leg.

A-7 MAJOR INJURIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7E	800-1000	200	Nose down 2°	ESCAPAC IG-2 TC	B - Compression fracture T4 & T5 Sprain R medial collateral ligaments knee. Contusion shoulders & upper anterior thigh.	Ejected using lower control aware of severe back pain and violent rapid tumbling. Was unable to stand due to pain in R knee. R side of visor struck by UNK object during ejection.
A-7E	8,000 AGL	350 est	Nose down 15° UNK left bank flat/oscillating spin	ESCAPAC IG-2 TC	B - Fracture C-2 pedicle w/slight subluxation. Fracture L fibula Laceration of chin. Laceration of L leg.	Pulled lower control while floating off seat in inverted spin. Experienced severe neck pain. Landed on a rock slide (60° slope).
A-7E	2,000	350 (tumbling noted) (water landing)	UNK	ESCAPAC IG-2	B - Probable compression fracture T3. Abrasions on shoulders. (anterior chest) & groin Hematoma & bruise on L mandible.	Following mid-air collision pilot was ejected from aircraft.
A-7E	2,000	350 (water landing)	UNK	ESCAPAC IG-2 TC	B - Compression fracture T12, L2, L3. Bilateral subconjunctival hemorrhage of eyes. Laceration wrist & L thigh.	Used lower control while hanging in straps.
A-7E	2,000	180	5° nose down	ESCAPAC IG-2 TC	B - Displaced fracture L distal fibula. Strain cervical spine. Multiple superficial lacerations both hands.	Used face curtain. Felt pain in neck on boost, felt pain in ankle on landing in rocks or roots.
A-7B	800 AGL	160	Nose up	ESCAPAC IG-2 TC	B - Muscle spasm & contusion neck. Abrasion R MTJ Dorsal index finger. Abrasion L tibia. Abrasion R lateral arm. Contusion inner thigh.	Ejected following engine failure using face curtain.

SYNOPSIS A-4 MAJOR INJURIES

1974 - 1978

<u>CATEGORIES</u>	<u>NUMBER</u>
o <u>SYSTEM FAILURES</u>	3 ^{a)}
- Premature opening survival kit	1 ^{b)}
- Misinstalled rocket	1
- Lower ejection control	1
o <u>INJURIES</u>	
- Vertebral	
- Cervical	
- Subluxation/fractures-dislocation	1 ^{c)}
- Fractures	3 ^{c)} g)
- Strain	1 ^{d)}
- Nerve Root compression	1 ^{e)}
- Thoracic	
- Fractures	2
- Lumbar	
- Fractures	2 ^{e)}
- Joints	
- Shoulder dislocation	1
- Shoulder fractures	2 ^{g)} g)
- Elbow fractures	1 ^{g)}
- Knee ligamental strains	3 ^{d)}
- Limbs	
- Arm fractures	2 ^{f)}
- Leg fractures	e ^{c)}
- Chest	
- Rib fractures	
- Dislocations	1
- Burns 1 ^{h)}	
- Brain concussion	1 ⁱ⁾
- Unconsciousness	2 ^{e)} k)

NOTES

- (a) Possibility of two other failures suggested by data:

TA-4J (seat not specified) Pilot attempted to open survival kit during descent to water. Despite pulling kit latching handle and removing the closure strap pin during descent, kit was not opened until some time after water entry.

TA-4J (ESCAPAC IC-3) Rear seat occupant believed he initiated command ejection sequence. However, pilot saw canopy jettison, was blinded temporarily by windblast then saw instrument panel and pulled face curtain. (Command ejection might not have been selected).

- (b) TA-4J (ESCAPAC IF-3) Should be noted that a similar case (A-4M ESCAPAC IF-3) caused parachute entanglement and resulted in a fatality.
- (c) TA-4J (ESCAPAC IG-3) Pilot during descent was unable to move head, neck or limbs. Survived since he landed on ground.
- (d) TA-4J (ESCAPAC IF-3) Pilot ejected high speed from uncontrolled aircraft, survival kit prematurely opened, landed in water and climbed into raft.
- (e) TA-4J (Seat not specified) Rear seat occupant used lower handle, rocket misinstalled, low trajectory, tumbled badly and had rapid parachute. Ejectee sustained fractures of leg bones and of L5, was unconscious until under water.
- (f) TA-4J (ESCAPAC IC-3) injuries sustained by pilot during post mid-air collision ejection. (See Note (a)).
- (g) TA4-J (ESCAPAC IG-3) Pilot struck ground near horizontal apparently just after parachute opening during the initial post-inflation collapse and swing through phase. Injuries attributed to ground impact.
- (h) TA-4J (ESCAPAC IG-3) Rear seat occupant descended on outskirts of aircraft fireball sustaining burns. Additional burns incurred in approaching aircraft looking for pilot (Note (g)).
- (i) TA-4J (ESCAPAC IC-3) Rear seat occupant suffered amnesia for 24 hours badly dazed (See Note (f) for pilot).

(k) TA-4F (ESCAPAC IC-3 Rear seat occupant sustained dislocated shoulder; believes he blacked out at parachute opening.

GENERAL NOTES

Three ejectees, and possibly a fourth, were unconscious, badly dazed and disoriented, and/or paralyzed as a result of their ejection.

A-4 MAJOR INJURIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
TA-4J	8,000	UNK	R spin nose down	ESCAPAC JF-3	B - Cervical strain. R & L medial collateral ligament strain. Abrasion and contusion left lateral neck. Abrasion right lateral neck. He felt his legs flailing.	Life raft caught in parachute risers. Survival kit opened prematurely. Use life raft, failed to disconnect parachute. Noted stiffness in neck as he descended. Helmet touched canopy had to lean forward to reach F.C. Suspended in harness due to spin.
TA-4J	1,000 (parachute open)	160 (50)	Nose low 30° L wing down 30° High descent rate Left hand turn	ESCAPAC IC-3	B - Compression fracture L1. Separation costochondral junction. Abrasion right neck (riser burn)	Seat contacted ground on collapsed parachute behind ejectee. Empty rear seat struck aircraft stabilizer.
TA-4F	9,000 MSL (landed on ground)	250 KIAS	15-20° nose down left bank 90-110°	ESCAPAC IC-3	G - R Jaw and neck contusions (O ₂ mask slap)	Pilot initiated ejection w/lower handle - failed. Then initiated successfully w/F.C. Heel pulled right, R hand on stick.
A-4L	12,000	250	UNK	ESCAPAC IA-1	B - Left shoulder dislocated (struck against canopy railing.)	Possible blackout noted at parachute opening.
					B - Probable compression fracture T-7. Ecchymoses acromio-clavicular areas - bilateral abrasions R side of neck.	Mid-air collision of wingman wing-tip and canopy. Pilot does not recall initiating ejection. Landed in tree.

A-4 MAJOR INJURIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
TA-4J	1,800	190 TAS	Nose down 10° Left bank 15°	ESCAPAC	G -- No Injury.	Pilot used face curtain. Could not open survival kit until in water.
	2,000 (parachute deployment was almost immediate)	205			B -- Compression fracture L5. Avulsion fracture greater tuberosities of bilateral humerus. Fracture lateral plateau L tibia. Avulsion fracture R fibula. 1st & 2nd degree burns 15% of body.	Used lower handle. Seat was observed by wing to exit w/large ball of flame underneath and pitch 90° aft immediately, barely clearing tail. Ejectee unconscious until under water.
A-4M	14,000	250-300	80° nose down Left hand spiral	ESCAPAC IG-3	B -- Comminuted fracture C-2 with minimal posterior movement. Loss of 1st R maxillary incisor.	Initiated escape w/F.C. seat full up. Noted pain in neck after parachute opening, unable to flex neck.
TA-4J	800 (water landing) (both seats tumbled 2 or 3 times)	220	Straight and level.	ESCAPAC IF-3	F -- Abrasion L cheek. Contusion R arm lateral aspect. Contusions and abrasions axillae & shoulders R & L. Contusions L anterior superior iliac spine area. Contusions popliteal fossae, distal thighs and proximal legs R & L.	Pilot used face curtain to initiate ejection.
				B --	B Strain of R knee medial collateral ligaments. Compression fracture T5. Contusion upper lateral R side chest wall. Contusion L superior medial-anterior surface.	Sequenced ejection. Saw pilot reach for F.C. and tried to position himself for impending ejection.

A-4 MAJOR INJURIES

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
TA-4J	2000 est (wing struck nose of another aircraft) (no injury caused by collision)	450 est	90°	ESCAPAC 1G-3	B Evulsion greater tuberosity L shoulder. Fracture L upper arm. Sprain L knee. Abrasion neck. Ecchymosis of face around eyes.	Mid air collision. Pilot believes he used F.C. Saw canopy go. Temporarily blinded by windblast, then seeing instrument panel pulled F.C.
					B Brain concussion. Abrasion R side of neck. Abrasion R arm. Bruise L hip. Ecchymosis of face. Amnesia for 24 hours.	Believes he used alternate handle, command ejection.
TA-4J	Ground	120	Take-off roll w/nose gear steering failure 2-3° nose down	ESCAPAC 1G-3	B Fracture of L clavicle. Fracture of L scapula. Compression fracture C5. Fracture L radial head (elbow) all attributed to ground impact.	Sequenced ejection landed horizontally feet first.
					B 2nd & 3rd degree burns hand and arms. 3rd degree burn back. 2nd degree burn knees position and anterior. All attributed to fire fall involvement.	Face curtain initiation of command sequenced ejection.
TA-4J	2000 (extreme tumbling noted) (landed on back in a thick briar bush) (seat twisting at man-seat separation noted & thought contributing to cervical injuries)	210	10-15° nose down	ESCAPAC 1G-3	B Subluxation C-6/C-7 w/fracture spinous process. Compression fracture C-7 C-8 nerve root compression. Contusion of R collar bone, clavical & shoulder regions.	Initiated escape w/lower handle. Unable to move extremities while descending.

A-7 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7A	3,500-4,000 (ground landing) (tumbling noted)	220	30° nose down	ESCAPAC IC-2	F Neck muscle strain. Abrasion - R dorsum of hand.	Pulled lower control as aircraft pitched violently downward after engine failure.
A-7E	600 MSL (tumbling seat separation) (ground landing)	200 KIAS	Nose up 5°	ESCAPAC IC-2	F Mild neck strain.	Face curtain following engine failure.
A-7C	3,330 AGL (ground landing)	200 KIAS (survival kit handle lost - could not open kit)	Nose down 2°	ESCAPAC IC-2	G No injuries listed	Face curtain following engine failure.
A-7C	200	120	Nose up 15°	ESCAPAC IC-2	G Minor pain in neck and back.	Face curtain.
A-7A	150 AGL (ground landing)	125 KIAS	Nose down 5-10°	ESCAPAC IC-2	G Minor cervical strain.	Lower control following hydraulic failure.
A-7C	15,000 (water landing)	300	Nose down 90°	ESCAPAC IC-2	G Abrasion, bilateral dorsum of feet. Mild neck muscle strain.	Lower control following mid-air collision - had difficulty reaching it due to negative G forces.
A-7B	7000	UNK	UNK	ESCAPAC IG-2 TC	F Soft tissue injury R knee. Aggravation of old injury R knee. Cervical spine and neck aggravation of old injury. Lumbar spine soft tissue.	Face curtain following mid-air collision.

A-7 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7E	7000 (slight tumble ing water landing)	200	Slight nose up	ESCAPAC IG-2 TC	F - Abrasion left hand. Abrasion L chin. Strain R sterno- cleidomastoid.	Pulled face curtain after electrical failure and flameout.
A-7E	1200 (water landing)	220	Nose up	ESCAPAC IG-2 TC	G - Abrasion posterior R neck. Abrasion R hand 2nd MP joint. Laceration L elbow. Mild neck strain.	Face curtain engine failure.
A-7B	50 (water landing)	780	Nose down 5-10° Left bank 45°	ESCAPAC IG-2 TC	F - Contusions R & L dorsums (feet).	Ramp strike following engine failure, aircraft broke up, ejected leaving deck using lower handle.
A-7E	1000 (tumbling noted) (DART not connected to aircraft) (ground landing - ejectee fell on water)	250	30° nose down 30° left bank rolling	ESCAPAC IC-2	G - Bilateral laceration of tongue. Massive hematoma & small laceration L buttocks.	Mid-air collision used lower control.
A-7E	5-10 KTS (ground landing) R canopy breaker evidence L canopy have deployed)	(cracked) ejectee breaker may not have deployed)	Nose down 10-20° Left bank 15-25° going over embankment.	ESCAPAC IG-2 TC	G - Muscle & ligament strain lumbo- sacral spine. Contusion posterior R thigh. Minor abrasions from being dragged.	Lower ejection handle after over- running runway.
A-7E	Ground (problem noted with sustainer rocket) (ground landing) (ejectee reported being dazed)	130	Nose up. Sliding on runway	ESCAPAC IG-2 TC	F - No injuries noted. Ejectee stated he delayed ejection due to doubts of seat reliability.	Lower control after lifting off, retracting gear and settling back on runway wheels up.

A-7 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-7E	60 (tumbling noted) (water landing)	135 (pilot was dazed)	--	ESCAPAC IG-2 TC	G Abrasion L foot. Minor burn L hand. Minor contusion L orbit.	Used lower control prior to aircraft impacting parked aircraft on deck.
A-7E	150 (water landing)	149 45° face down	Left wing down 30-45°	ESCAPAC IG-2 TC	G Cervical spine strain.	Face curtain during control failure following launch.
A-7E	6,500 (water landing)	0	Flat, upright non-oscillatory spine. Nose down 10°	ESCAPAC IG-2 TC	G Upper back - Interscapular area muscles strained w/mild spasm. Fracture tooth #8. Left eyebrow & adjacent area 1° burn. L wrist 1° burn. Tender teeth and sore jaw.	Lower control from out of control aircraft.
A-7E	60 (water landing)	50	Sliding off bow cold cat shot Nose down 20° Right bank 5°	ESCAPAC IG-2 TC	F(3) Multiple lacerations of lower lip.	Cold cat shot, lower control.
A-7E	80 (landed in wooded area)	150 (area)	Nose up 3° Shallow level descent.	ESCAPAC IG-2 TC	G Abrasion R dorsum (hand)	Face curtain used after loss of power.

A-4 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-4E	Ground level 0	80-100	Level Sliding down runway on wing tanks	ESCAPAC 1A-1	Mild back strain TB/T12. Contusion L buttock.	Ejection initiated with lower hand while sliding gear up on runway. Bent down to look for handle before ejecting.
TA-4J	11,000'	200 KIAS	Inverted flat spin	ESCAPAC 1G-3	G Neck and back muscle strain.	Both occupants pushed against canopy by negative G.
		(unable to open kit) (landed on ground)			G Small contusions with muscle strain in neck.	Pilot was ejected w/o warning by command sequence initiated by rear seat occupant.
A-4M	6,000'	350+	Nose down 70-80° rolling L	ESCAPAC 1F-3	F Cervical strain. Abrasions and contusions L and R shoulders Bruises posterior buttocks.	Face curtain
		(unable to open kit) (kit retention straps torn away) (landed in water)				
A-4L	Ground level (noted backward summersault)	110	Straight & level on runway	ESCAPAC 1A-1 (NES-1G-A chute)	G Contusion over eye Contusion of knee Bruise R shoulder	Aircraft fire, uncontrollable shortly after landing. Face curtain. Helmet visor broken by unknown cause.
A-4L	1,000' (Ground landing)	200	Straight & level	ESCAPAC 1A-1	F Mild cervical strain Contusion on thorax (Grounded 24 days in lieu of 5 since he would not return to activity until then - - reservist.	Engine flameout. Face curtain
A-4E	5,000' est. (Ground landing)	300 est.	Spin, left turn, nose down	ESCAPAC 1A-1	F Ligamentous strain L knee Ligamentous strain R knee Contusion and abrasions anterior neck Numerous other muscular skeletal aches and pains.	Pushed against canopy during spin.

A-4 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
A-4E	14,000	350	Tumbling	ESCAPAC 1A-1	G No injuries listed. Pain in R lateral calf.	Ejection followed mid-air collision. Lower ejection handle.
TA-4J	2,000' (Landed on ground) (Flailing noted) (Tumbling noted)	300	Nose up 15°	ESCAPAC 1C-3	G Abrasions and ecchymosis of skin ~ riser burn	Command ejected following bird strike, hands on throttle and stick.
					F Laxity lateral and medial collateral ligaments (knee) Sprain and laceration R wrist (bird strike)	Initiated escape with lower control. Helmet damaged by bird strike.
TA-4J	Ground 0 (landing on ground)	80-100	Nose level, wings level	ESCAPAC 1G-3	F Hematoma and muscle strain right thigh and knee	Take-off roll loss of control. Lower control.
					G Slight abrasions face and neck	
TA-4J	12,00 (Water landing) (Seat kit sank after release of find lanyard)	100-124 (flailing noted) (Seat kit sank after release of find lanyard)	Nose down spin lap belt fittings	ESCAPAC 1G-3	F Strain L shoulder subjunctional hemorrhage both eyes.	Both pilots forced up against canopy by negative G.
				--could not	G No injuries listed	Lower control, command ejection.
TA-4J	1500-2000 (Landed in a tree) (Notes unconsciousness) (Lost seat pan release handle, O ₂ sheared off)	150	Nose down 30° pin stabilized upright hesitation	ESCAPAC-1G-3	G Contusions and tenderness posterior/inferior aspect of both thighs Laceration dorsum of R wrist (trees?)	Used lower control

A-4 OTHERS

1974 - 1978

A/C	ALTITUDE	SPEED	ATTITUDE	SEAT TYPE	INJURY DESCRIPTION	EJECTION DESCRIPTION
TA-4J	750 (ground landing)	150	Wings level	ESCAPAC 1C-3	G Abrasion L knee. Abrasion L elbow. Abrasion R knuckles Abrasion forehead	Was ejected following flameout and accidentally jettisoning canopy.
TA-4J	4,500 AGL 8,500 MSL (RSSK damaged on seat-man separation) kits retention straps failed, ground landing)	230-250 KIAS	Wings level 15° nose down (0° nose down) (ground landing)	ESCAPAC 1F-3 torn from kit both	G Strained muscles posterior neck G Contusion shoulder G Sprain R foot and 5th metatarsal. Contusion anterior shoulder mild hyperextension cervical strain G No injuries	Initiated command ejection w/ lower control. Face curtain command eject Command ejected holding torso harness
A-4H	5,000 MSL 3,000 AGL (Felt heat of fireball) lift 4,200 (Water landing)	285	Nose 80-90° down (ground landing) Nose down 95° inverted spin	ESCAPAC 1A-1	G Minor abrasions L and R shoulders and inguinal areas L conjunctival hematoma temporal aspect G Lacerations, multiple minor of neck (wore religious chain) Two minor lacerations L wrist (Lost wrist-watch) Both forearm-cactus needle punctures Contusion R forearm medial aspect	Face curtain Lower control-had difficulty due to being against canopy. Lower control.
TA-4J	9,000 MSL 7,500 AGL (landed in cactus patch) (Arm flailing)	7,200	Nose down 30-60° inverted oscillating spin	ESCAPAC 1G-3	G Lumbar strain	Face curtain flameout after take-off
TA04J	350 (Ground landing)	115 (DART improperly rigged)	Nose up 5° (properly rigged)	ESCAPAC 1G-3		

GENERALIZED ESCAPE
SYSTEM DEVELOPMENTAL
HISTORY

**GENERAL INFORMATION CONCERNING
AAES RELIABILITY & MAINTAINABILITY**

Have you heard of the wonderful one-hoss shay,
That was built in such a logical way
It ran a hundred years to a day,
And then, of a sudden, it—ah, but stay,
I'll tell you what happened without delay,
Scaring the parson into fits,
Frightening people out of their wits,—
Have you ever heard of that, I say?

THE DEACON'S MASTERPIECE, OR THE
WONDERFUL "ONE-HOSS SHAY"

A LOGICAL STORY
OLIVER WENDELL HOLMES

Now in building a chaises, I tell you what,
There is always *somewhere* a weakest spot,—
In hub, tire, fellowe, in spring or thill,
In panel, or crossbar, or floor, or sill,
In screw, bolt, thoroughbrace,—lurking still,
Find it somewhere you must and will,—
Above or below, or within or without,—
And that's the reason, beyond a doubt,
That a chaise *breaks down*, but doesn't *wear out*.

THE DEACON'S MASTERPIECE OR THE
WONDERFUL "ONE-HOSS SHAY"

A LOGICAL STORY
OLIVER WENDELL HOLMES

But the Deacon swore (as Deacons do,
With an "I dew vum," or an "I tell yeou,")
He would build one shay to beat the taown
'N' the keounty 'n' all the kentry raoun';
It should be so built that it *couldn'* break daown:
"Fur," said the Deacon, "'t's mighty plain
Thut the weakes' place mus' stan' the strain;
'N' the way t' fix it, uz I maintain,

Is only jest

T' make that place uz strong uz the rest."

THE DEACON'S MASTERPIECE, OR THE
WONDERFUL "ONE-HOSS SHAY"

A LOGICAL STORY
OLIVER WENDELL HOLMES

First of November, Fifty-five!
This morning the parson takes a drive.
Now, small boys, get out of the way!
Here comes the wonderful one-hoss shay,
Drawn by a rat-railed, ewe-necked bay.
“Huddup!” said the parson.—Off went they.

The parson was working his Sunday’s text,—
Had got to *fifthly*, and stopped perplexed
At what the—Moses—was coming next.
All at once the horse stood still,
Close by the meet’n’-house on the hill.
First a shiver, and then a thrill,
Then something decidedly like a spill,—
And the parson was sitting upon a rock,
At half past nine by the meet’n’-house clock,—
Just the hour of the Earthquake shock!
What do you think the parson found,
When he got up and stared around?
The poor old chaise in a heap or mound,
As if it had been to the mill and ground!
You see, of course, if you’re not a dunce,
How it went to pieces all at once,—
All at once, and nothing first,—
Just as bubbles do when they burst.

End of the wonderful one-hoss shay.
Logic is logic. That’s all I say.

THE DEACON’S MASTERPIECE, OR THE
WONDERFUL “ONE-HOSS SHAY”

A LOGICAL STORY
OLIVER WENDELL HOLMES

COUNTING IN-SERVICE FAILURES

- ATTEMPTING TO MAKE RELIABILITY ESTIMATES ON BASIS OF IN-SERVICE USAGE DIFFICULT AND AND UNRELIABLE PROBLEMS AFFECTING CREDIBILITY OF SUCH DATA INCLUDE ESPECIALLY TWO MAJOR ONES:

- LARGE NUMBER OF SEATS NEVER RECOVERED
- VARYING DEGREE OF EXPERTISE APPLIED IN EXAMINING RECOVERED SEATS.

- USN POSITION EXPRESSED IN:

MIL-STD-2067 AIRCREW AUTOMATED ESCAPE SYSTEMS RELIABILITY AND MAINTAINABILITY (R/M) PROGRAM REQUIREMENTS

"3.2.6 IN SERVICE SUCCESS RATE. THAT PERCENTAGE OF EJECTING AIRCREW WHO SURVIVED THROUGH SEPARATION FROM THE ESCAPE SYSTEM AND SURFACE CONTACT. INCLUDES MANY "LUCKY" OR "FLUKE" SAVES FROM AMONG THE "OUT-OF-ENVELOPE" EJECTIONS, UNSUCCESSFUL (NONMALFUNCTION) "OUT-OF-ENVELOPE" EJECTIONS, OTHER NONMALFUNCTION FATALITIES, AND SYSTEM MALFUNCTION CAUSED FATALITIES. SEPARATION OF THESE EFFECTS TO CORRECT THE SUCCESS RATE TO OBTAIN A MEASURE OF IN-SERVICE RELIABILITY IS A MATTER OF JUDGMENTAL INTERPRETATION OF ACCIDENT DATA OF VARYING VERACITY AND AS SUCH IS NOT AN ACCEPTABLE QUANTIFICATION OF AAES RELIABILITY."

AAES MALFUNCTIONS

TYPES OF MALFUNCTION

- PRECLUDE INFLIGHT
ESCAPE FROM AIR-
CRAFT
- IMPAIR AAES
OPERATION

- NOT ALL AAES MALFUNCTIONS PRECLUDING INFLIGHT ESCAPE FROM AIRCRAFT SHOW IN EJECTION STATISTICS.
- ▲ THOSE THAT DO ARE FATAL ATTEMPTS TO EJECT.
- ▲ SURVIVORS, HOWEVER, SURVIVE NOT BECAUSE OF THE AAES, BUT BECAUSE OF SOME OTHER METHOD OF ESCAPE AND ARE SO CODED.
- RECORDS EXAMINED REVEALED 35 ESCAPES ATTEMPTED, BUT NOT ACCOMPLISHED CASES WITH 17 FATAL EJECTION ATTEMPTS AND 18 NON-EJECTION SURVIVAL METHODS.

- MIL-S-18471 DEFINES EJECTION SEATS
AS ELEMENTS OF

AIRCREW AUTOMATED ESCAPE SYSTEMS

REQUIRING THAT ALL ESCAPE SEQUENCE
EVENTS OCCUR AUTOMATICALLY FOLLOWING
ACTUATION OF A SINGLE CONTROL.

- FAILURE OF AN ACTUATED CONTROL TO
INITIATE THE ESCAPE SEQUENCE OR
INTERRUPTION OF THAT SEQUENCE,
WHETHER OR NOT EJECTEE MANUALLY BY-
PASSES THE FAILURE POINT IS A SYSTEM
FAILURE.

NAVY IDENTIFIED

ESCAPAC FAILURES DURING PERIOD REVIEWED BY DAS 1/1/74-6/30/78

2 - RSSK - PREMATURE OPENING AT SEPARATION
4 - RSSK - OPENING PREVENTED BY DAMAGED AT
SEPARATION.
3 - LANYARD FAILURES
3 - SEAT MAN SEPARATION FAILURES
3 - SEAT FAILED TO FIRE
1 - WINDBLAST INDUCED EJECTION
2 - SUSTAINER ROCKET FAILURES
1 - LOWER HANDLE FAILED
1 - PARACHUTE DID NOT DEPLOY (ARMING CABLE RELEASE)
1 - CANOPY BREAKERS FAILED
21 FAILURES IN 140 NAVY ATTEMPTS

COUNTING IN-SERVICE FAILURES (CONT'D)

- USN DETAILED REVIEW OF ESCAPAC USAGE RECORDS REVEALED THAT OUT OF 140 EJECTIONS DURING PERIOD COVERED BY DAS REVIEW:

- ONLY 80 SEATS WERE RECOVERED OR RECOVERABLE (ALL OVERLAND EJECTIONS CONSIDERED RECOVERABLE-- NOT KNOWN HOW MANY WERE).
- 21 KNOWN FAILURES WERE IDENTIFIED (DETAILS FOLLOWING CHART).
- 17 FAILURES WERE IDENTIFIED AMONG RECOVERED/ RECOVERABLE SEATS.

- GIVEN $F = 21$, $N = 140$

$$R_{.90LCL} = .81$$

- HOWEVER, SINCE 60 SEATS WERE LOST IN OCEAN AND NOT RECOVERED, MORE REALISTIC ESTIMATE GIVEN BY

$$F = 17, N = 80:$$

$$R_{.90LCL} = .71$$

ESTIMATES OF ESCAPAC IN-SERVICE RELIABILITY
(1/1/74 - 6/30/78)

ESCAPAC SEAT TYPE							
IA-1	IC-2	IC-3	IE-1	IF-3	IG-2	IG-3	TOTAL
3	3	3	1	5	3	3	21
3	2	2	1	3	3	2	16
17	25	19	5	15	32	27	140
11	13	13	5	4	15	20	81
.436	.590	.590	.343	.013	.560	.717	.730
.604	.718	.641	.343	.423	.775	.737	.800

NUMBER OF FAILURES

NUMBER OF FAILURES
WITH RECOVERED SEATS

TOTAL NUMBER OF ATTEMPTS

NUMBER OF ATTEMPTS
WITH RECOVERED SEATS

RELIABILITY BASED UPON
RECOVERED SEATS AT 90% LCL

RELIABILITY BASED UPON
TOTAL ATTEMPTS AT 90% LCL

INTERPRETATION OF RELIABILITY AT A LOWER CONFIDENCE LEVEL (CONT'D)

- RELIABILITY IS AN INHERENT FEATURE OF PRODUCT'S DESIGN THAT CANNOT BE MEASURED DIRECTLY.
- TRUE RELIABILITY (R_T) CAN BE QUANTIFIED ONLY AS ESTIMATES BASED UPON TRIAL (TEST) RESULTS.
- CONFIDENCE LEVELS ARE USED TO EXPRESS PROBABILITY THAT R_T IS BOUNDED BY ESTIMATED RELIABILITY VALUES.
- LOWER CONFIDENCE LEVEL RELIABILITY VALUES (R_{LCL}) EMPLOYED AS NOT CONSERVATIVE ESTIMATE OF R_T .
- PROBABILITY R_T IS BELOW R_{LCL} EQUALS $\frac{1 - LCL}{2}$.
- THEREFORE NAVY USE OF $R_{90LCL} = .98$ STATES USN CONFIDENCE OF 95 PERCENT THAT R_T IS EQUAL TO, OR GREATER THAN 0.98.

RELIABILITY

INTERRELATIONSHIP BETWEEN RELIABILITY AND CONFIDENCE LEVEL DEFINED BY:

$$C = 1 - R^N$$

WHERE

C IS CONFIDENCE LEVEL

R IS RELIABILITY

N IS NUMBER OF TESTS, WITHOUT FAILURES.

RELIABILITY

MANIPULATING THE PREVIOUS EQUATION AS FOLLOWS

$$C = 1 - R^N$$

$$R^N = 1 - C$$

$$N \times \ln R = \ln(1 - C)$$

$$R = e^{\ln(1 - C)/N}$$

CALCULATION OF RELIABILITY BASED UPON OBSERVED FAILURE RATE (CONT'D)

- FROM THESE DATA, THE DAS CALCULATIONAL APPROACH IS:

$$R = 1 - \frac{\text{FAILURES}}{\text{NO. OF TRIALS}}$$

$$= 1 - \frac{4}{179}$$

$$= 0.978$$

- USING THESE DATA (F=4, N=179) SYSTEM RELIABILITY AT 90 PERCENT LOWER CONFIDENCE LEVEL IS:

$$R_{.90_{LCL}} = 0.956 \quad (\text{OBTAINED FROM TABLES})$$

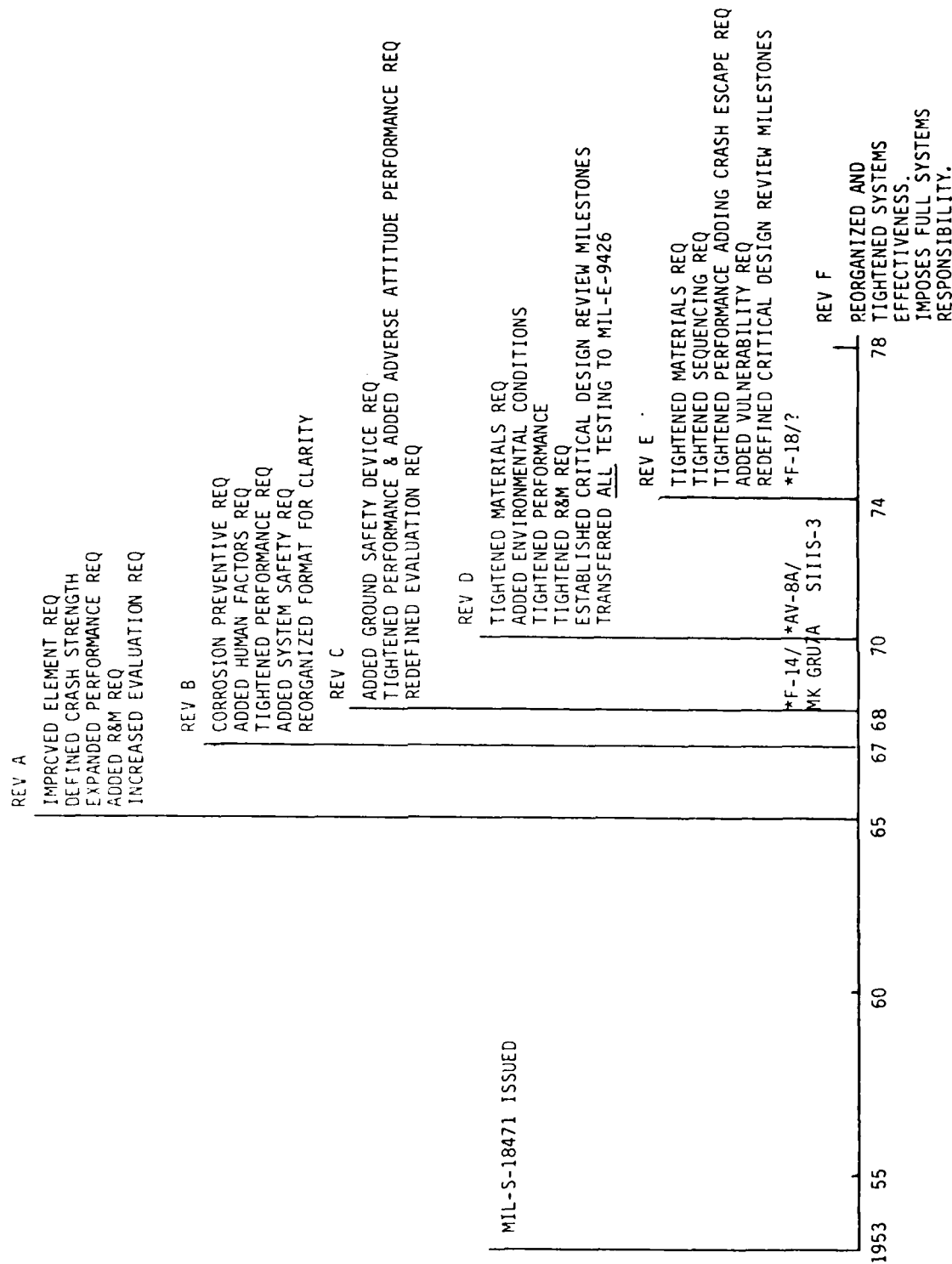
- LOWER CONFIDENCE LEVEL FOR DAS CALCULATED RELIABILITY IS:
71 PERCENT (OBTAINED FROM TABLES)

USN CONFIDENCE IN NEW SEAT RELIABILITIES

(CONT'D)

- RELIABILITY IS DESIGNED IN, NOT TESTED INTO A SYSTEM.
- TESTING PROVIDES DATA WITH WHICH TO ESTIMATE SYSTEM RELIABILITY.
- NAVY SINCE PROCURING INITIAL ESCAPACs HAS UPGRADED
 - DESIGN REQUIREMENTS
 - RELIABILITY, MAINTAINABILITY, SAFETY, HUMAN FACTORS REQUIREMENTS
 - CONTINUOUS DESIGN EVALUATION PROCEDURES
 - TESTING REQUIREMENTS.
- NO ESCAPACs HAVE BEEN PROCURED UNDER THESE. HOWEVER, NEW SEATS HAVE AND REPLACEMENT SEAT WILL BE.
- THESE UPGRADED REQUIREMENTS/PROCEDURES ENHANCE PROBABILITY OF ACHIEVING HIGHER RELIABILITIES WHILE ACHIEVING MAJOR ADVANCES IN PERFORMANCE.

MIL-S-18471 HISTORY



AIRCREW AUTOMATED ESCAPE SYSTEM

SYSTEMS EFFECTIVENESS PROGRAM TOOLS

RELIABILITY

- RELIABILITY SYSTEM BLOCK DIAGRAM & MATH MODEL
- FMEA (FAILURE MODES AND EFFECTS ANALYSIS)
- FTA (FAULT TREE ANALYSIS)
- SINGLE POINT FAILURE ANALYSIS
- ENVIRONMENTAL STUDY
- CRITICAL DESIGN REVIEWS
- COMPONENT PARTS & MATERIAL SELECTION/QUALIFICATION
- SUPPLIER CONTROLS
- FAILURE DATA COLLECTION & ANALYSIS
- FAILURE SUMMARIES
- MOS (MARGINALITY OF SUCCESS ANALYSIS)
- RELIABILITY GROWTH CURVES

MAINTAINABILITY

- MAINTAINABILITY SYSTEM BLOCK DIAGRAM & MATH MODEL
- MAINTAINABILITY GROWTH CURVES
- FMK (FIELD MAINTAINABILITY REVIEW KIT)

SYSTEMS SAFETY

- HMEA (HAZARDS MODES AND EFFECTS ANALYSIS)
- FTA (FAULT TREE ANALYSIS)
- OHA (OPERATION HAZARD ANALYSIS)

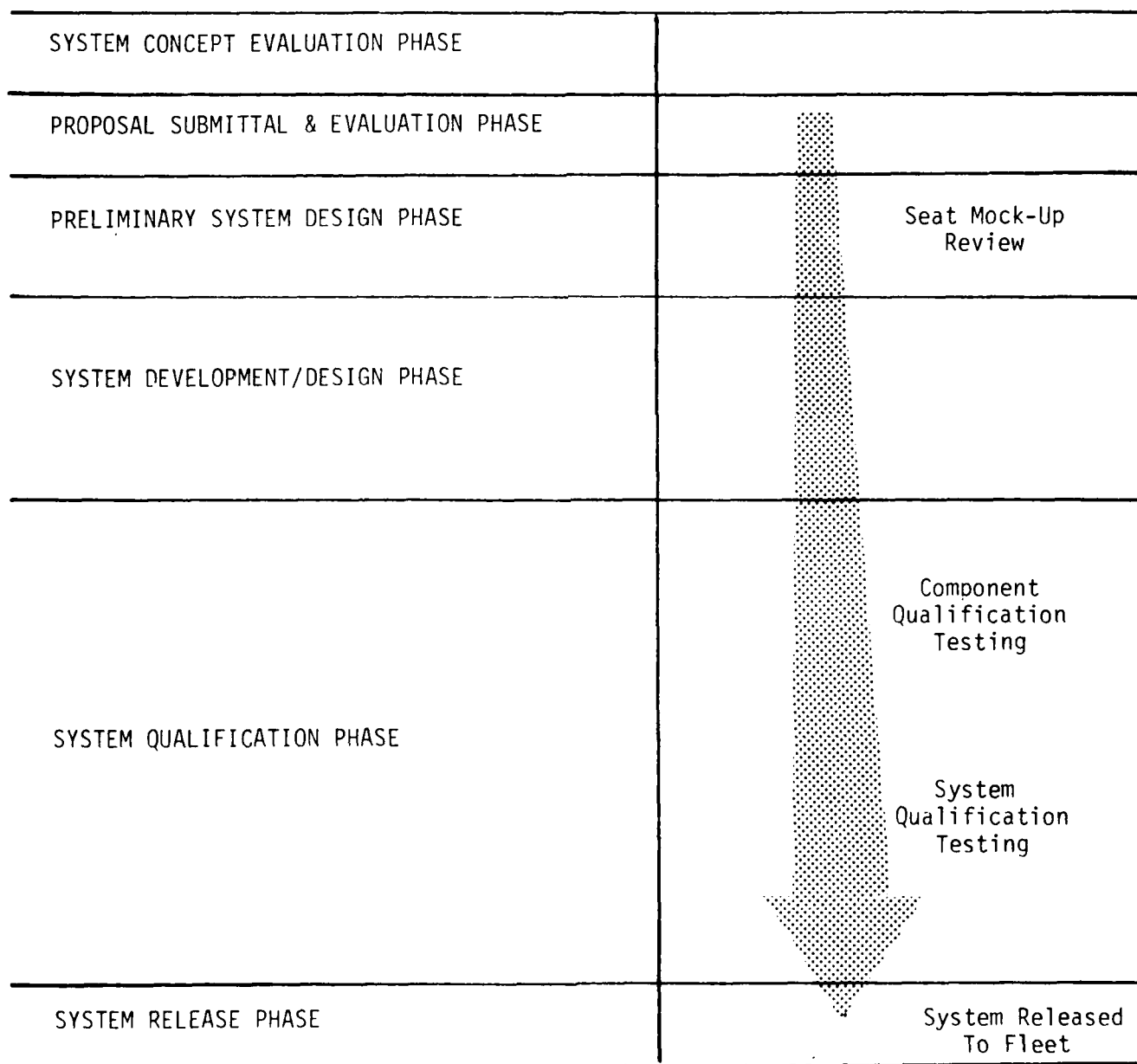
VULNERABILITY ANALYSIS

- CIFMEA (COMBAT-INDUCED FAILURE MODE AND EFFECT ANALYSIS)
- HIT RATE ANALYSES
- VULNERABILITY DESIGN REVIEWS

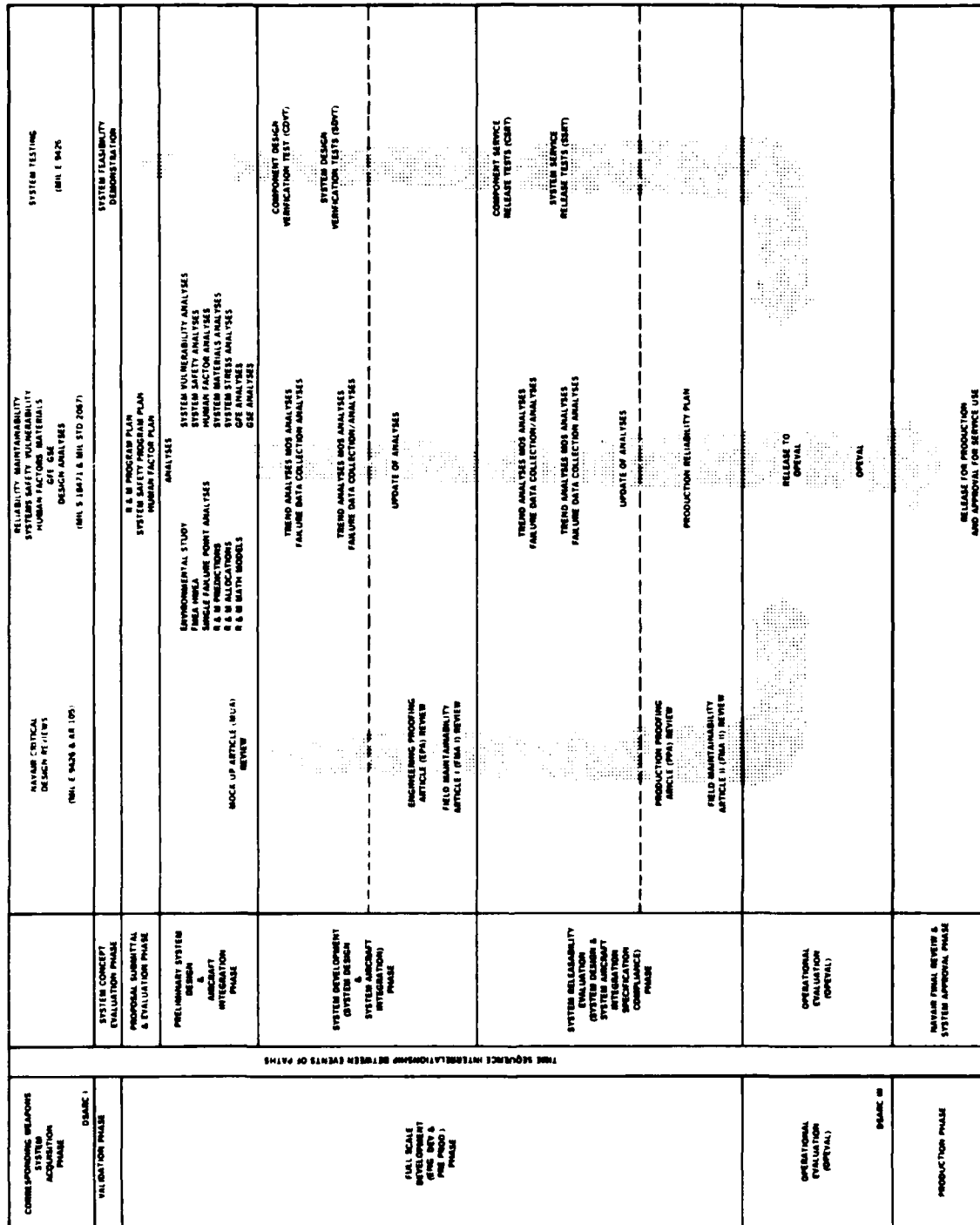
CHANGES HISTORY

NAVAIR EJECTION SEAT DESIGN EVALUATION PROGRAM

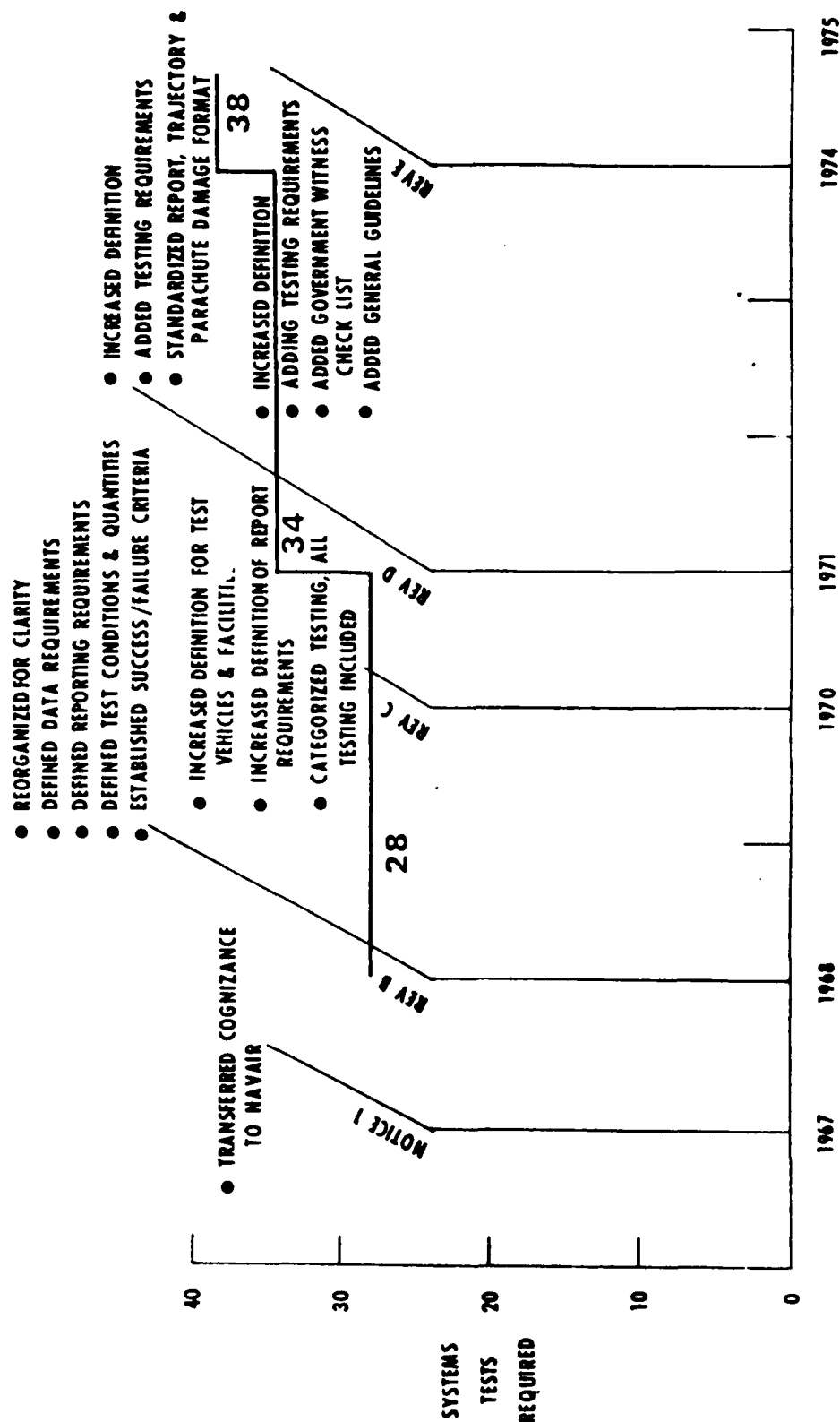
PRE-1968 EVENT FLOW SEQUENCE



AIRCREW AUTOMATED ESCAPE SYSTEM DESIGN EVALUATION PROGRAM EVENT FLOW SEQUENCE DIAGRAM



MIL-E-9426 HISTORY LISTING MAJOR CHANGES



MAINTAINABILITY

- **MAINTAINABILITY IS AN INHERENT FEATURE OF A SYSTEM'S DESIGN.**
- **MAINTAINABILITY CAN BE CONTROLLED DURING DESIGN OF A SYSTEM.**
- **MAINTAINABILITY CANNOT BE TESTED INTO A SYSTEM'S DESIGN.**

EQUIPMENT FAILURES DUE TO FAULTY MAINTENANCE

- NOT ALL FAULTY MAINTENANCE WORK IMPACTS EJECTIONS. SOME IMPACT FLIGHT. SOME IMPACT GROUND PERSONNEL SAFETY.
- NOT ALL FAULTY MAINTENANCE IS FOUND AS A CONSEQUENCE OF EJECTION FAILURES. SOME IS DETECTED BY INSPECTION. SOME IS DETECTED THROUGH SUBSEQUENT MAINTENANCE.

MANY, IF NOT MOST, "MAINTENANCE
ERRORS" RESULT FROM OVERLY
HUMAN DEPENDENT DESIGN

RECENT DESIGN REQUIREMENTS
AIMED AT ELIMINATING
HUMAN DEPENDENCY DESIGNS

MAJOR DESIGN & DESIGN EVALUATION EFFORTS
FOR NEWER EJECTION SEATS WERE CONCEN-
TRATED ON :

- REDUCING MAINTENANCE FREQUENCY
- ELIMINATING MAINTENANCE ERROR POTENTIALS.
(ELIMINATE HUMAN DEPENDENCY DESIGNS)

ASSURANCE CONCERNING NEW SEAT MAINTAINABILITY

- MAINTAINABILITY IS AN INHERENT FEATURE OF A SYSTEM'S DESIGN.
- SINCE PROCURING INITIAL ESCAPACs, NAVY HAS INTRODUCED AND UPGRADED ESCAPE SYSTEM
 - MAINTAINABILITY DESIGN REQUIREMENTS:
 - EXTENDED PERIODS BETWEEN MAINTENANCE ACTIONS
 - EASE AND SAFETY OF PERFORMING MAINTENANCE
 - SPECIFIED E-4 SKILL LEVEL CAPABILITY PERFORM 95% OF ALL MAINTENANCE
 - IMPOSED MAXIMUM TIME LIMITS ON PERFORMING MAINTENANCE
 - MAINTAINABILITY DESIGN EVALUATION REQUIREMENTS
 - MAINTAINABILITY TESTING REQUIREMENTS:
 - TWO SPECIAL TESTS (FIELD MAINTAINABILITY REVIEWS)
 - SPECIAL ATTENTION DURING ALL TESTING.
- NO ESCAPACs HAVE BEEN PROCURED UNDER THESE REQUIREMENTS WHILE NEW SEATS HAVE BEEN AND REPLACEMENT SEAT WILL BE.
- THESE UPGRADED REQUIREMENTS/PROCEDURES ENHANCE PROBABILITY OF ACHIEVING SIGNIFICANTLY IMPROVED SEAT MAINTAINABILITY WHILE ACHIEVING MAJOR ADVANCES IN PERFORMANCE.

RELIABILITY AND MAINTAINABILITY REQUIREMENTS

**DETAILED REQUIREMENTS IN ADDENDUM 3 OF RFP (TAILORED VERSION OF
MIL-STD-2067 R&M FOR ESCAPE SYSTEMS)**

CALCULATED RELIABILITY AT LEAST 0.98 @ 90%

DMMH/FH PER SEAT SHALL NOT EXCEED 0.05 HOURS

MTTR SHALL NOT EXCEED 0.85 HOURS

MAXIMUM CORRECTIVE MAINTENANCE TIME SHALL NOT EXCEED 2.5 HOURS

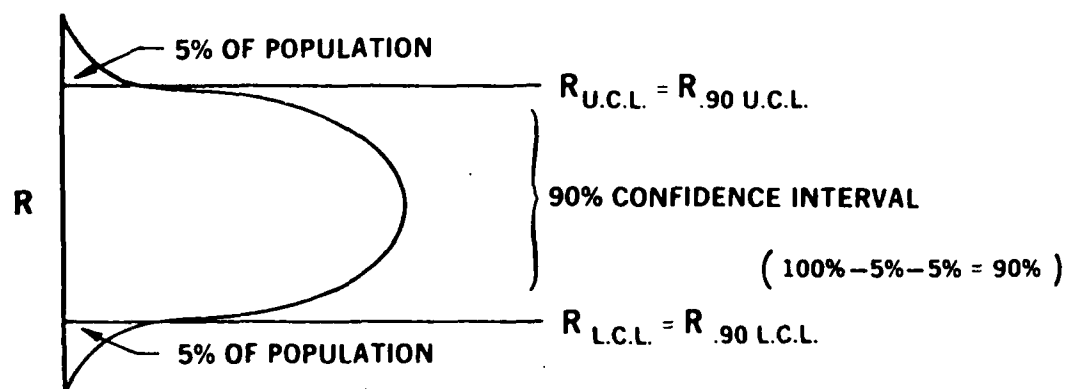
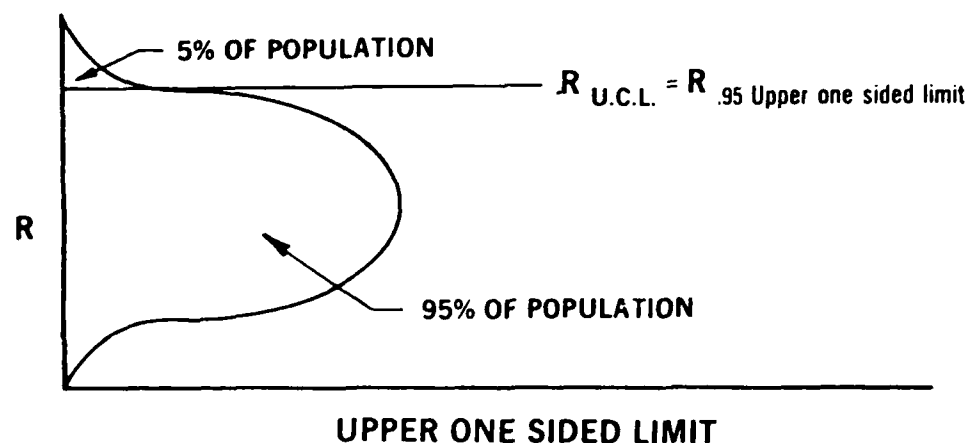
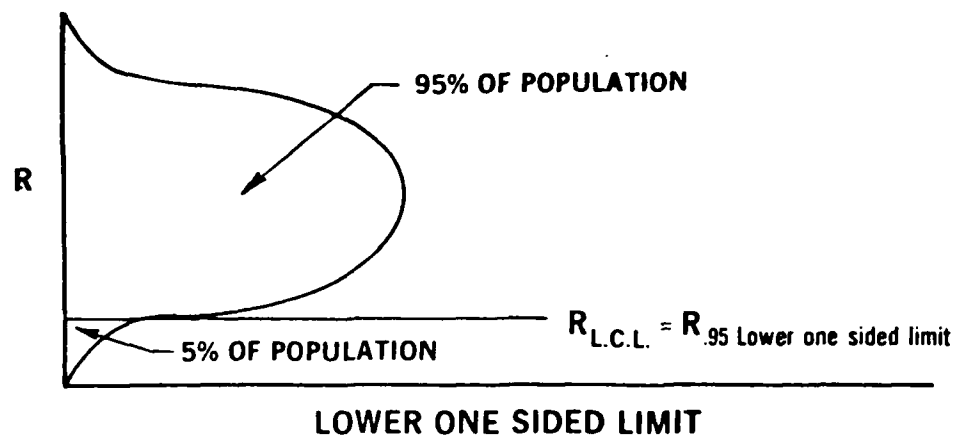
**E-4 MAINTENANCE PERSONNEL ABLE TO PERFORM 95% OF TOTAL
MAINTENANCE ACTIONS**

RELIABILITY

- RELIABILITY IS AN INHERENT FEATURE OF A SYSTEM'S DESIGN.
- RELIABILITY CAN BE CONTROLLED DURING DESIGN OF A SYSTEM.
- RELIABILITY CANNOT BE DIRECTLY MEASURED, IT CAN ONLY BE ESTIMATED ON THE BASIS OF RESULTS OF SYSTEM TRIALS.
- RELIABILITY CANNOT BE TESTED INTO A SYSTEM'S DESIGN.

SYSTEM RELIABILITY

- TRUE VALUE OF NON-PHYSICAL ATTRIBUTES INCAPABLE OF BEING DIRECTLY MEASURED CAN ONLY BE ESTIMATED THROUGH OBSERVING RESULTS OF TRIALS OF SYSTEM POSSESSING THOSE ATTRIBUTES.
- ESTIMATION PROCESSES INVOLVE ATTEMPTING TO "BOUND" TRUE VALUE WITHIN AN UPPER BOUND AND A LOWER BOUND.
- BOUNDING TECHNIQUES INVOLVE STATISTICAL LIKELIHOOD THAT TRUE VALUE IS EITHER:
 - GREATER THAN UPPER BOUND, OR
 - LESS THAN LOWER BOUND.
- THIS "CONFIDENCE LEVEL" IS MEANS FOR EXPRESSING PROBABILITY THAT TRUE VALUE BEING ESTIMATED IS CONTAINED WITHIN THE ESTIMATED BOUNDS.



**COMBINED LOWER AND UPPER ONE SIDED LIMITS WITH
LOWER AND UPPER CONFIDENCE INTERVAL LIMITS**

SAMPLE CALCULATIONS FOR 90% CONFIDENCE INTERVAL

- **PROBABILITY TRUE SYSTEM RELIABILITY GREATER THAN 90% UPPER CONFIDENCE LEVEL VALUE:**

$$\frac{1 - \text{CONFIDENCE INTERVAL}}{2} = \frac{1 - .90}{2} = .05$$

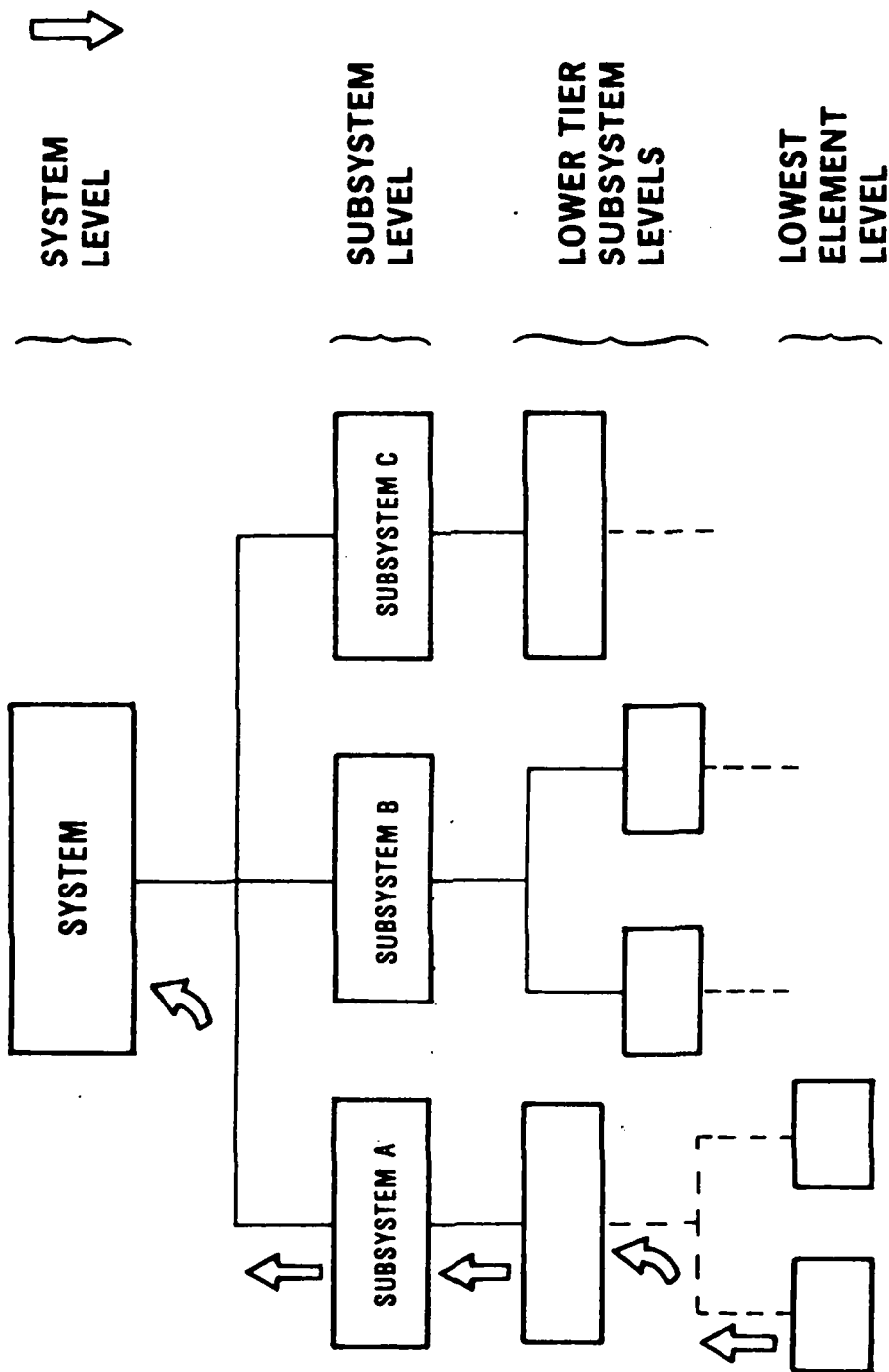
- **PROBABILITY TRUE SYSTEM RELIABILITY LESS THAN 90% LOWER CONFIDENCE LEVEL VALUE:**

$$\frac{1 - \text{CONFIDENCE INTERVAL}}{2} = \frac{1 - .90}{2} = .05$$

- **PROBABILITY TRUE SYSTEM RELIABILITY EQUAL TO, OR GREATER THAN 90% LOWER CONFIDENCE LEVEL VALUE:**

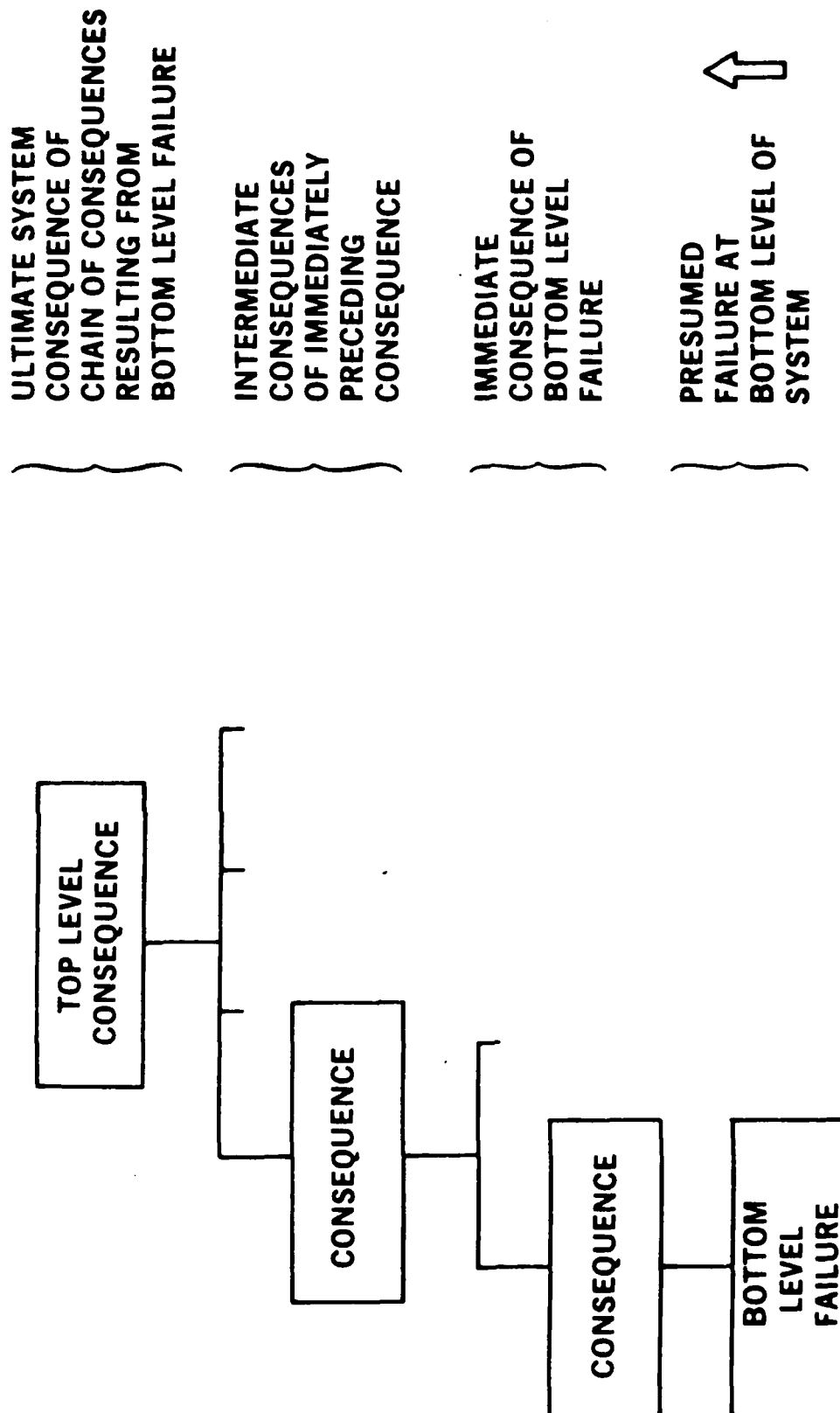
$$\frac{1 + \text{CONFIDENCE INTERVAL}}{2} = \frac{1 + .90}{2} = .95$$

BLOCK DIAGRAM

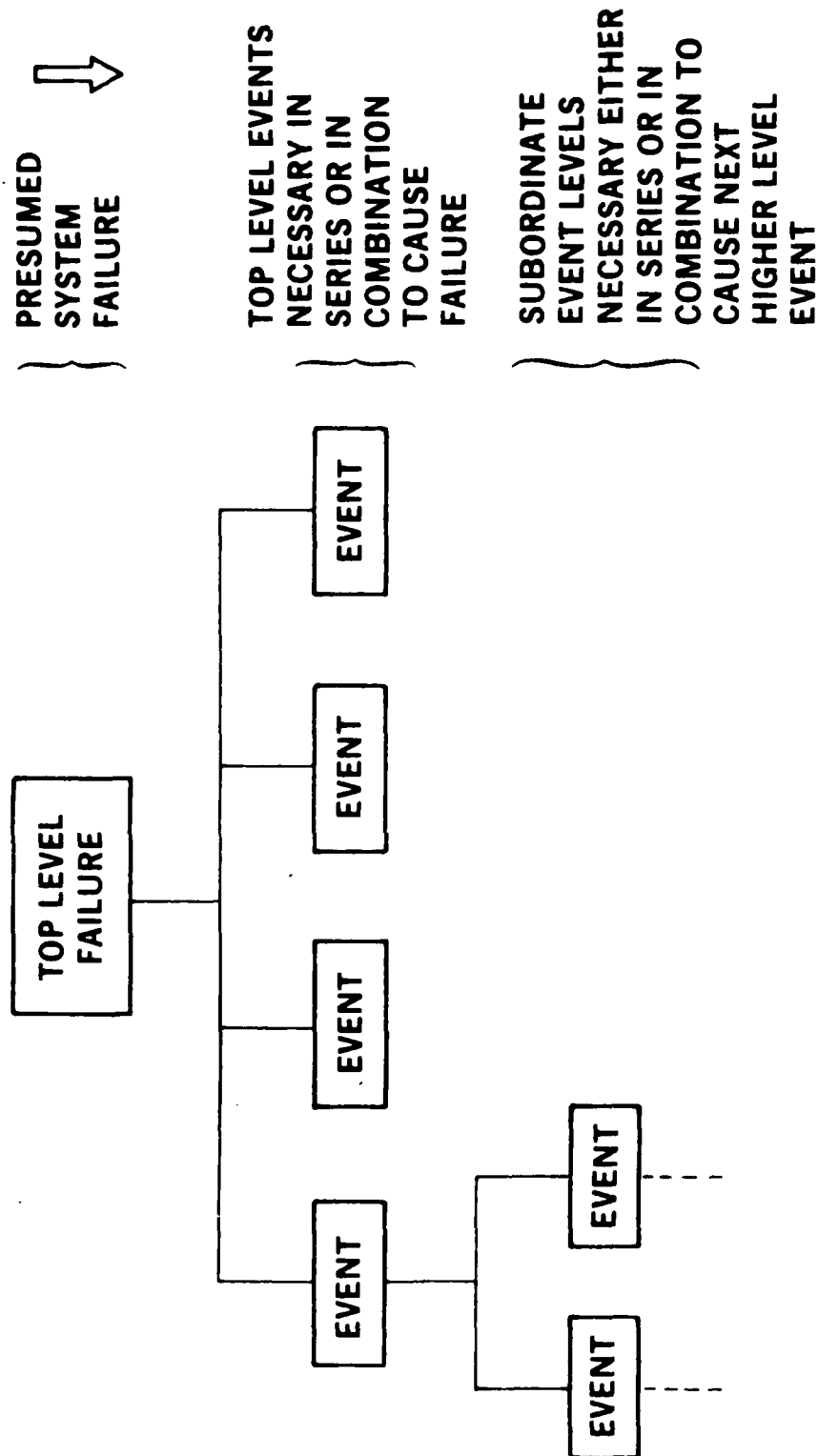


NOTE:
 ARROWS (—) DEPICT ONE OF THE FUNCTIONAL TRAINS

FMEA



FTA



PHASES OF MOS ACTIVITIES (I)

● PRE-TEST PLANNING

— REVIEW "ILITIES" ANALYSES

- ▲ POSSIBLE TEST CONDITION IMPACT UPON ARTICLE OPERATION**
- ▲ TYPES OF ARTICLE CONDITION CHANGES (TRANSITORY & PERMANENT)**

- CORRECT OPERATION**
- PARTIALLY INCORRECT OPERATION**
- INCORRECT OPERATION**

▲ TYPES OF DATA NEEDED TO DOCUMENT ARTICLE CONDITION CHANGES

- REVIEW MOS ARCHIVAL DATA**
- REVIEW TEST PLANS & DATA PROGRAM PLANS**

▲ TEST DATA ACQUISITION PROCEDURES & SYSTEM ADEQUACY

- TEST SET-UP DOCUMENTATION PLANS**
- TEST DATA ACQUISITION SYSTEM**

- — DATA PRIORITIES**
- — BACK-UP DATA ACQUISITION**
- — SYSTEM CHECK-OUT**
- — SYSTEM CALIBRATION**

■ POST-TEST DATA ACQUISITION PLANS

- — TEST SITE PROTECTION/ACCESS CONTROL PLANS**
- — TEST SITE SAFETY INSPECTION/DOCUMENTATION PLANS**
- — MOS ON-SITE DATA ACQUISITION PROVISIONS**
- — MOS TEST ARTICLE RECOVERY/TRANSPORT PROVISIONS**

PHASES OF MOS ACTIVITIES (II)

● TEST SITE

— PRE-TEST

▲ REVIEW TEST SET-UP DOCUMENTATION FOR ADEQUACY

- TEST ARTICLE PRE-TEST CONDITION/COMPLIANCE WITH PLAN
- TEST EQUIPMENT PRE-TEST CONDITION/COMPLIANCE WITH PLAN
- TEST SITE PRE-TEST CONDITION/COMPLIANCE WITH PLAN

▲ REVIEW TEST DATA ACQUISITION SYSTEM DOCUMENTATION FOR ADEQUACY

- SYSTEM COMPLIANCE WITH PLAN
- SYSTEM CALIBRATION

— POST-TEST

▲ REVIEW TEST DATA ACQUISITION SYSTEM POST-TEST CALIBRATION CHECKS

▲ CHECK TEST SITE SAFETY INSPECTOR DOCUMENTATION

■ ELEMENTS DISTURBANCE DOCUMENTATION

- — ELEMENT IDENTIFIED
- — ELEMENT LOCATION & CONDITION DESCRIBED
- — NATURE OF DISTURBANCE DESCRIBED (I.E. MOVED, SAFETIED, ETC.)

■ SITE DECLARED SAFE

▲ CONDUCT ON-SITE DOCUMENTATION OF POST-TEST CONDITION OF ARTICLE, EQUIPMENT & SITE

- LOCATE MAP & IDENTIFY ALL ELEMENTS
- PHOTOGRAPH UNDISTURBED ELEMENTS
- DESCRIBE UNDISTURBED CONDITION OF ELEMENTS
- PREPARE ELEMENTS FOR TRANSPORTATION

- — DESCRIBE CHANGES OCCURRING IN ELEMENTS CONDITION

PHASES OF MOS ACTIVITIES (III)

● POST-TEST INVESTIGATION

— PRELIMINARY TEST ARTICLE POST-TEST CONDITION DESCRIPTION

▲ PREPARE UTILIZING ALL PRE-TEST & ON-SITE DOCUMENTATION

▲ IDENTIFY ALL KNOWN ANOMALIES

- TRANSITORY CONDITIONS & CONDITION INTERRELATIONSHIPS**
- PERMANENT CONDITIONS & CONDITION INTERRELATIONSHIPS**

▲ IDENTIFY ALL KNOWN NON-ANOMALOUS CONDITIONS

▲ DEVELOP TEST ARTICLE AUTOPSY PLANS & SUPPORTING RATIONALE

- TO EXPLORE ANOMALOUS CONDITIONS IN DEPTH**
- TO DOCUMENT PRESENCE/ABSENCE OF PREVIOUSLY EXPERIENCED ANOMALIES**

▲ AUTOPSY PLAN REVIEW

- DESIGNERS**
- "ILITIES"**
- MANUFACTURING**
- QUALITY ASSURANCE**
- PROGRAM MANAGEMENT**

— CONDUCT TEST ARTICLE AUTOPSY

▲ STEP-BY-STEP DOCUMENTATION OF PROCEDURES FOLLOWED/CONDITIONS OBSERVED

— CONDUCT ANALYSIS OF DATA

▲ ARCHIVAL REFERENCE FOR PAST EXPERIENCE

▲ ASCERTAIN MOST LIKELY SETS OF CONDITIONS & SEQUENCES OF EVENTS LEADING TO OBSERVED DATA

— PREPARE PRELIMINARY MOS REPORT

PHASES OF MOS ACTIVITIES (IV)

● MOS REVIEW

— MOS REVIEW BOARD

▲ COMPOSED OF REPRESENTATIVES OF

- ENGINEERING**
- "ILITIES"**
- MANUFACTURING**
- PURCHASING**
- QUALITY ASSURANCE**
- TESTING**
- MOS INVESTIGATOR**

▲ IDENTIFY

- PROBABILITY OF ANOMALY OCCURRENCE**
- ANOMALY CONSEQUENCE POTENTIAL SEVERITY**
- COST TO FIX**
- TIME TO FIX**
- NEED FOR, COST & TIME FOR, AND TYPE OF ADDITIONAL INVESTIGATION**

▲ FINALIZE REPORT

- IDENTIFYING ALL OBSERVED ANOMALIES WHETHER UNDERSTOOD OR NOT**
- IDENTIFYING ALL RECOMMENDED ADDITIONAL INVESTIGATION**
- IDENTIFYING ALL FINDINGS CONCERNING OBSERVED ANOMALIES**
- INCLUDING ALL RECOMMENDATIONS CONCERNING REMEDIAL ACTIONS**

— PROGRAM MANAGEMENT/CORPORATE REVIEW

- ▲ CONTRACTUAL SCOPE**
- ▲ IMPLEMENTATION DECISIONS**
- ▲ REFERRAL DECISIONS**

— GOVERNMENT PROCURING AGENCY OR DESIGNEE REVIEW

PHASES OF MOS ACTIVITIES (V)

● ARCHIVAL

- IDENTIFY PARTS CONTAINING ANOMALIES & RETAIN FOR PROGRAM
- IDENTIFY ALL OTHER PARTS & HOLD IN REFERENCE RESERVE
 - ▲ NON-PERMANENT (HOLD FOR SEVERAL TESTS)
 - ▲ HELD IN EVENT NEW ANOMALY OBSERVED IN LATER TEST
- INITIATE ANOMALY TRACKING SYSTEM
 - ▲ UPDATE AFTER EACH TEST
 - ▲ RECORD MARGIN BY WHICH ELEMENT/SYSTEM FAILURE AVOIDED
- MAINTAIN FAMILIAL DATA SYSTEM
 - ▲ UPDATE AFTER EACH TEST
 - ▲ RECORD TRENDS AND/OR STATISTICAL RELATIONSHIP TO FAILURE LIMITS

REQUIRES LARGE DESIGNED

"TRUE" RELIABILITY TO

PROVIDE HIGH PROBABILITY

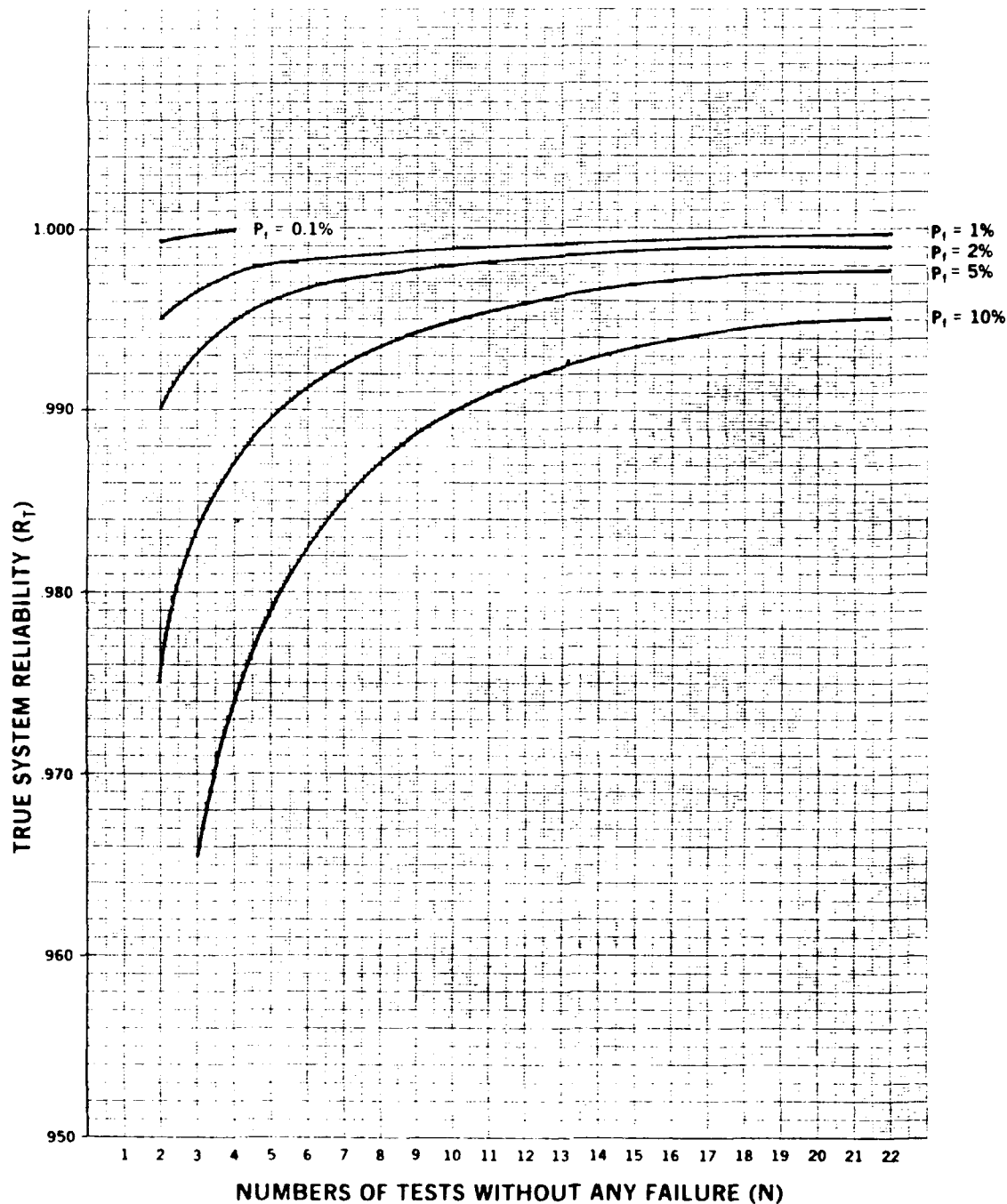
OF DEMONSTRATING A

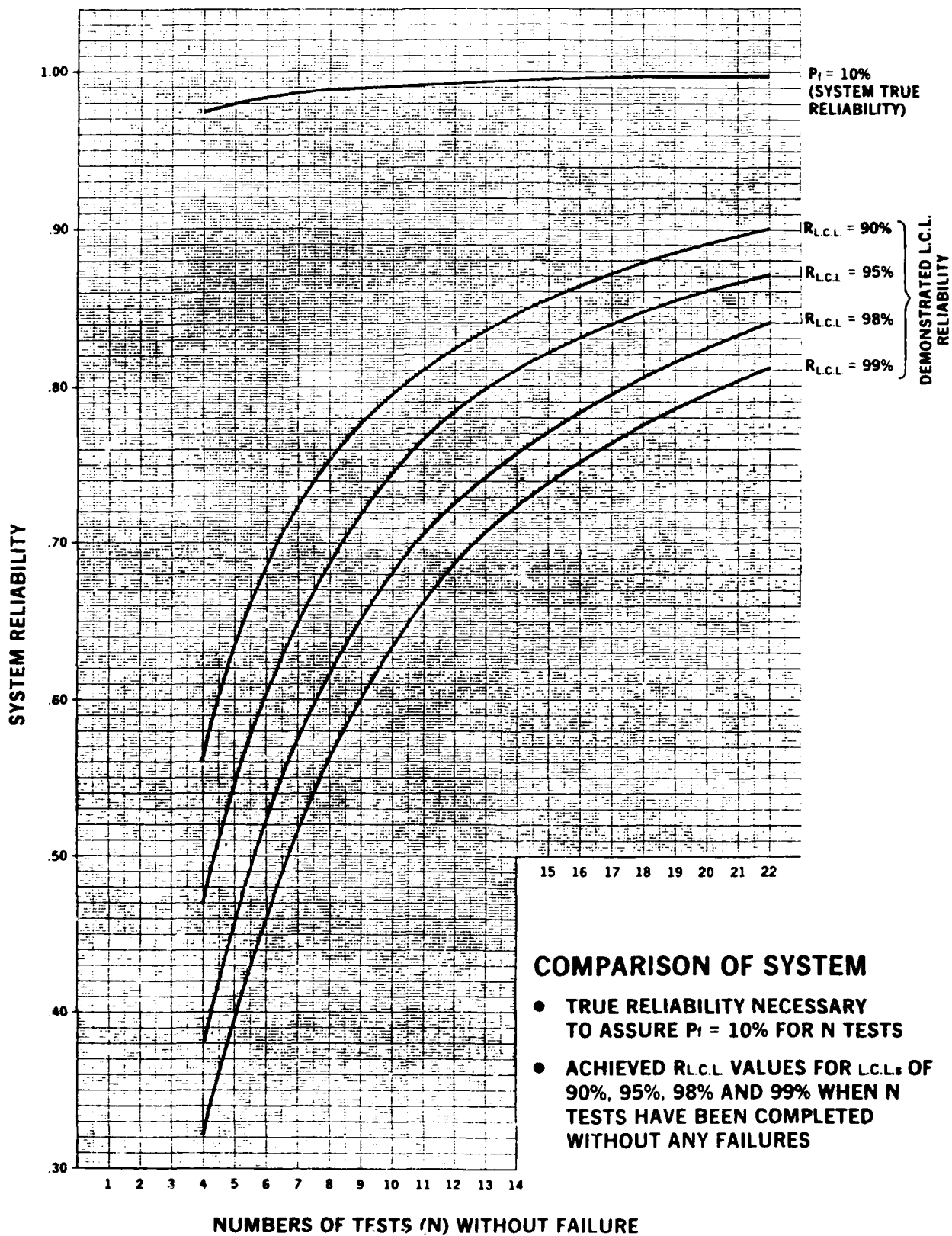
MUCH LOWER "DEMONSTRATED"

RELIABILITY.

TRUE SYSTEM RELIABILITY NECESSARY TO
ASSURE SPECIFIC MINIMAL (NOT TO EXCEED)
LEVELS OF P_f (PROBABILITY OF FAILING TO
COMPLETE A TEST SERIES (N) SUCCESSFULLY)

$$R_T = e^{\frac{\ln(1-P_f)}{N}}$$





PUBLISHED REFERENCE DATA CONCERNING

PHYSIOLOGICAL LIMITS

USED BY NAVAIR

Abrupt Acceleration

"In this time period, tissues react by structural damage or failure. Tissue damage is determined by such physical properties as tissue elasticity, viscosity, frequency of response, tensile and shearing strength, and compressibility. Stress on solid tissues (e.g., bone) produces little or no displacement until the yield point is reached, when fracture results. In visco-elastic tissues (muscle, skin, internal organs), unit stress produces logarithmic displacement; in body fluids, displacement is linear."

Pages 447-448
Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963

"Biologically, the limiting factor in human tolerance to headward g in the normal, seated posture is spine fracture, particularly in the upper lumbar portion, just above the "small of the back" concavity. With optimum alignment, up to 35g can be tolerated at less than 500g/sec rate of onset, but, with the back bent forward to the limit of motion, this limit diminishes to below 15g. Animals with spines optimally aligned have withstood 75g (hogs) and 65g (chimpanzees) without fracture at higher than 5,000g/sec onset. Human limits are presumably in this area, but data are lacking. With optimum support, as in immersion baths or form-fitting couches, the limit might be about 1,000g in "zero" time (0.001 sec)."

Page 448

Human Engineering Guide to Equipment Design

Morgan, Chapanis, Cook, Lund

McGraw-Hill Book Company, Inc.

1963

Brief Acceleration

"At about 0.2 sec duration, hydraulic effects begin. These consist of the displacement of fluids in the body cells, changes in the hydrostatic equilibrium between small blood vessels and their surrounding body fluids, changes in permeability and structural failure of blood vessels, and the mechanical displacement or deformation of body structures. Body orientation determines the physiological effect of the hydraulic displacements."

Pages 448-452

Human Engineering Guide to Equipment Design

Morgan, Chapanis, Cook, Lund

McGraw-Hill Book Company, Inc.

1963

"Human tolerance to abrupt acceleration involves the following five mechanical factors:

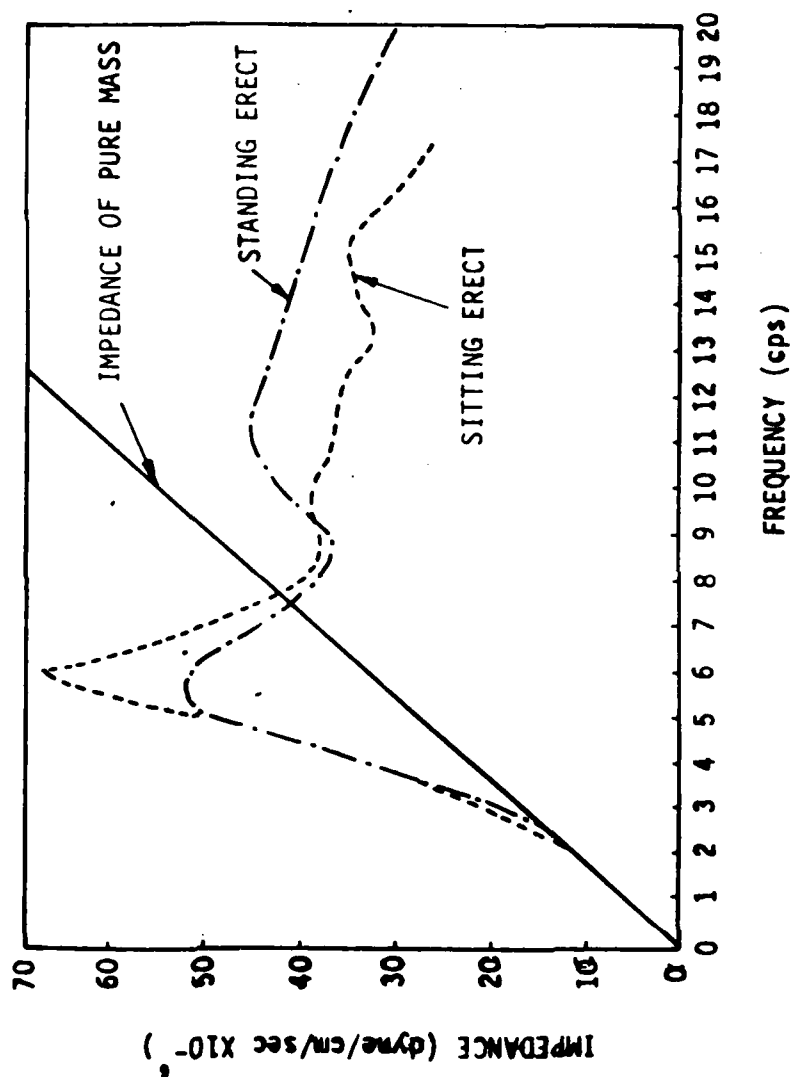
- a. The type of body support or restraint.
- b. The orientation of the body with respect to the direction of force.
- c. The rate and duration of application of the force.
- d. The magnitude of the force.

Of these factors, the type of restraint is probably the most important..."

(Underlining added)

Page 448

Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963



Page 469
 Human Engineering Guide to Equipment Design
 Morgan, Chapanis, Cook, Lund
 McGraw-Hill Book Company, Inc.
 1963

"Parachute opening shock is a special case of total body deceleration acting over a 1-2 sec period with the body in various positions. Peak forces, acting for about 0.05 sec, will vary from 8-33g, depending on altitude and on the 4th power of parachute-opening velocity (Webster, 1953)."

"Both operating experience and experiments (Hallenbeck, et al., 1945) indicate that opening shock is greatest at high altitudes. Forces below 20g are considered to be safe, forces of 20-30g are borderline, and forces of over 30g are dangerous for man, parachute, and harness."

Page 452

Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963

Pitch Rate

"In the pitch axis, with the center of rotation at the heart level, symptoms of negative acceleration (-Gz) are demonstrated at about 80 rpm and are tolerable for only a few seconds. Some effects of positive acceleration (+Gz), namely numbness and pressure in the legs, are also observed but develop slowly, with pain being evident at about 90 rpm. No confusion or loss of consciousness is found, but in some subjects disorientation, headache, nausea, or mental depression are noted for several minutes after a few minutes of exposure (Weiss et al., 1954).

(Underlining added)

Page 192

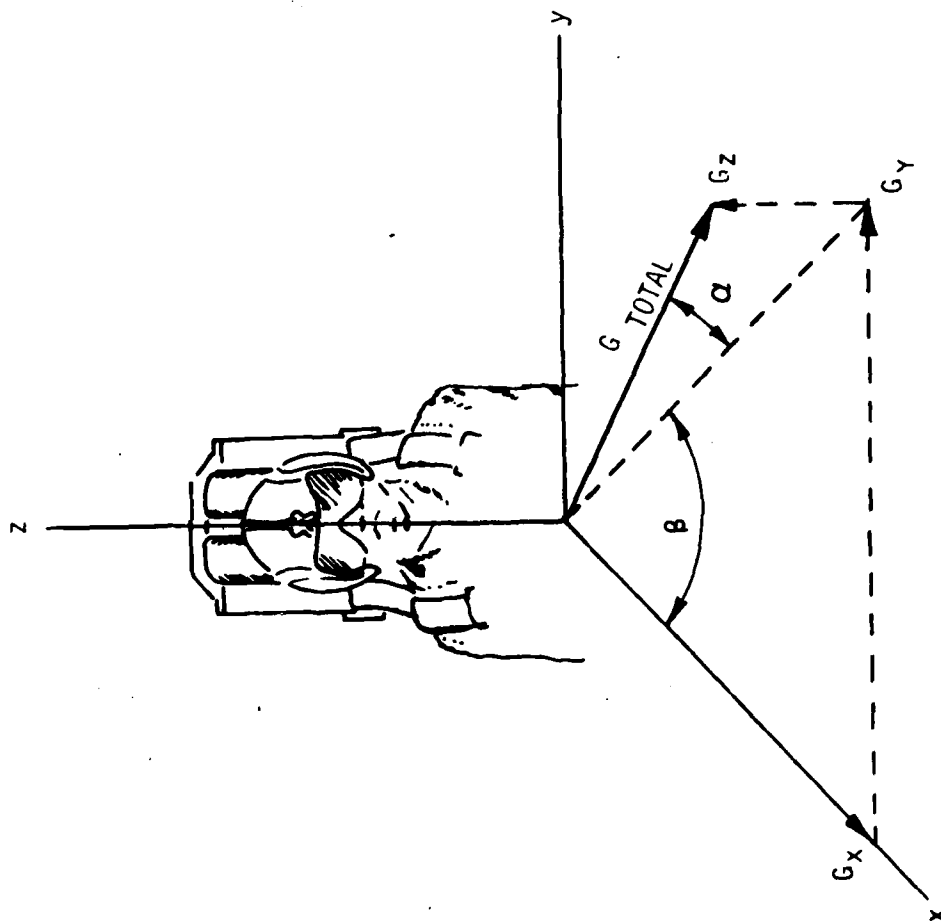
Bioastronautics Data Book

J. F. Parker, Jr., Vita R. West

National Aeronautics and Space Administration
1973

"For transverse g in the seated position, tolerance limits are set by hemorrhage into the eyes, retinal detachment, chest pain, and difficulty in breathing. The following forces are tolerable: 3g for 900 sec, 10g for 120 sec, 15g from 5-50 sec, and 25g for 1 sec. In the well supported prone and supine positions, transverse-g tolerance will probably be limited only by the strength of the heart or lungs."

Page 452
Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963



LATERAL ACCELERATION (G_y)

$$G_y = (G_{TOTAL})(\cos \alpha)(\sin \beta)$$

TABLE 6-3. COMPLAINTS REGISTERED BY VOLUNTEERS IN APOLLO IMPACT TESTS

Pos. No.	Seat Orientation (Roll-Pitch-Yaw)	Complaint Tests Total Tests	Category of Complaints	Complaint G Range	Sled G Range
1	000-315-000	2/14	4,9	13.2 - 24.6	5.7 - 26.3
2	000-335-330	3/10	7,8,10,10	17.3 - 21.0	6.0 - 21.0
3	000-005-320	2/14	4,8,9,9,10	17.5 - 25.6	9.2 - 25.6
4	000-035-330	4/12	1,1,4,4,6	18.5 - 25.0	10.5 - 25.0
5	000-045-000	5/14	2,4,4,4,5,5,6,9,9,9	5.9 - 25.0	5.9 - 25.0
6	000-035-030	6/12	2,4,4,5,8,9,9,10	18.5 - 24.5	10.2 - 24.5
7	000-005-040	4/11	2,4,4,6,7,9	14.2 - 23.5	10.0 - 23.5
8	000-335-030	1/14	4,9	19.5	8.0 - 24.7
9	000-085-180	1/2	2,4,10	9.8	9.8 - 11.8
10	000-085-220	2/13	4,10,10	13.9 - 15.4	5.9 - 16.0
11	000-085-270	0/2	No complaints	17.4 - 18.7	17.4 - 18.7
12	000-085-320	2/21	1,1,4	15.7 - 17.8	6.4 - 19.5
13	000-085-000	0/2	No complaints	14.6	9.4 - 11.1
14	000-085-040	1/13	4	-	5.8 - 18.2
15	000-085-090	0/2	No complaints	-	11.6 - 13.5
16	000-085-140	3/14	4,5,5	15.1 - 16.0	5.5 - 18.9
17	000-045-180	9/17	1,1,2,2,3,3,3,5,5,5, 5,5,6,7,7,7,7,8,8, 9,10,10	15.0 - 26.1	15.0 - 26.1
18	000-035-210	8/20	1,1,2,2,3,4,5,6,6,6, 7,7,7,8,9	15.2 - 23.2	10.5 - 28.9
19	000-005-220	5/16	1,5,5,6,9,9	16.5 - 28.2	16.5 - 30.0
20	000-335-210	1/6	2	19.8	15.8 - 21.7
21	000-315-180	1/10	2,3	19.0	15.8 - 21.9
22	000-335-150	0/8	No complaints	-	15.0 - 21.9
23	000-005-140	8/19	2,2,4,5,6,8,9,9,9,9, 9,9,10	16.4 - 30.7	16.3 - 30.7
24	000-035-150	8/19	1,1,2,2,5,5,5,6,6,7	11.0 - 29.3	11.0 - 29.3

Note: ¹Headache - Incidence at impact, duration up to several hours.

²Stunning/disorientation - Incidence at impact but of brief duration.

³Blurred vision/spots before eyes - Incidence at impact but of brief duration.

⁴Neck/back muscle spasm/strain - Delayed onset, lasting up to several days.

⁵Chest pain - Incidence at impact but of brief duration.

⁶Shortness of breath - Incidence at impact but of brief duration.

⁷Abdominal visceral displacement sensation - At impact.

⁸Joint pain - Delayed onset and lasting up to several days.

⁹Lower extremity muscle spasm/pain - Delayed onset and lasting up to several days.

¹⁰Upper extremity muscle spasm/pain - Delayed onset and lasting no longer than 1 day.

(Brown et al., 1966)

Page 243

Bioastronautics Data Book

Parker, West

National Aeronautics and Space Administration

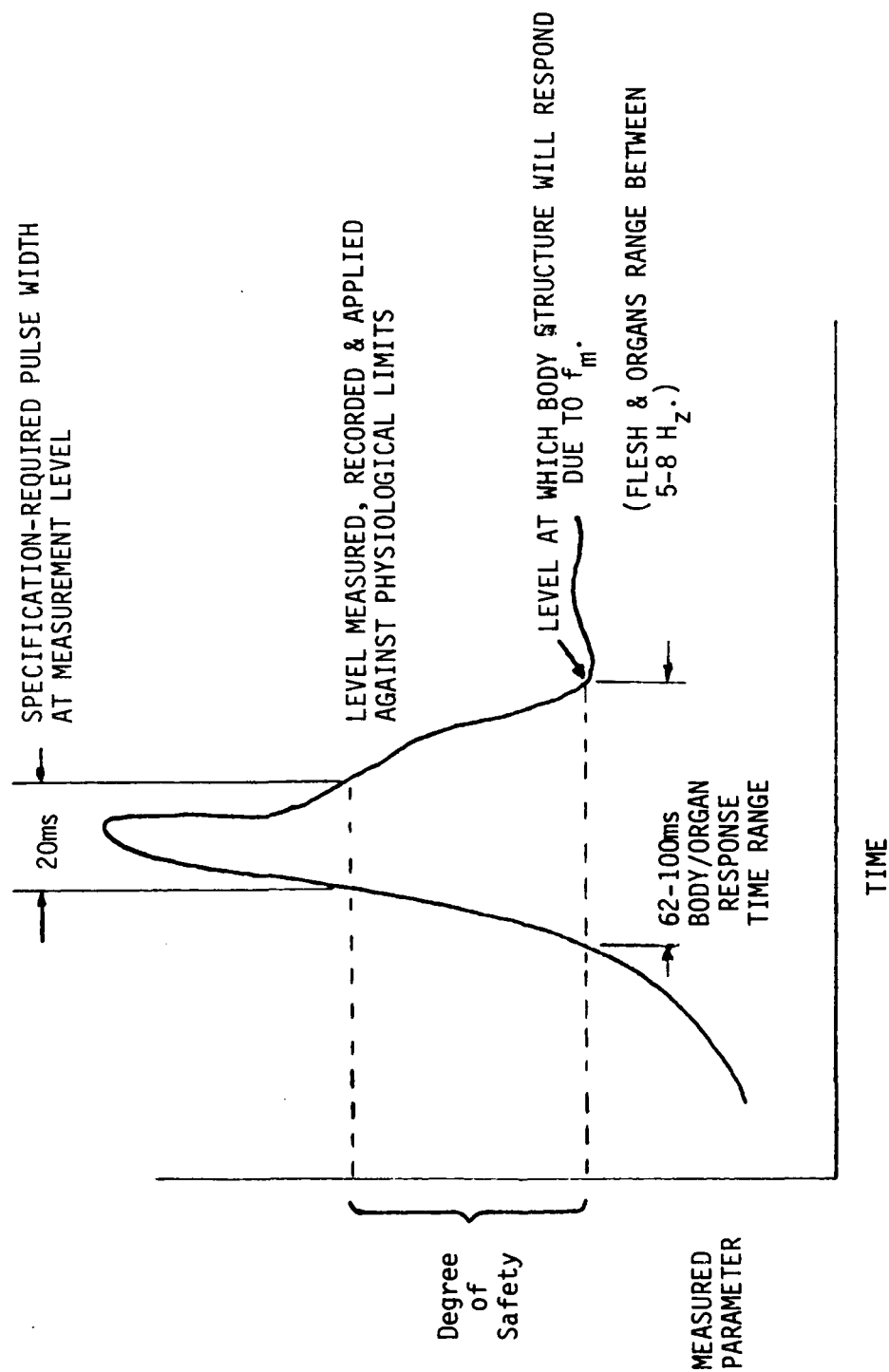
1973

RANGE OF LATERAL ACCELERATION (G_Y)
CAUSING SUBJECT COMPLAINTS*

$$G_Y = (G_{TOTAL})(\cos 50)(\sin 400)$$

POSITION NO.	G_{TOTAL}		G_Y	
	MIN	MAX	MIN	MAX
3	17.5	25.6	11.2	16.4
7	14.2	23.5	9.1	15.0
19	16.5	28.2	10.6	18.1
23	16.4	30.7	10.5	19.7

* NO MAJOR INJURIES REPORTED



AD-A171 639

AIRCRAFT AUTOMATED ESCAPE SYSTEMS (AAES) DATA ANALYSIS
PROGRAM SYMPOSIUM H. (U) NAVAL SAFETY CENTER NORFOLK VA
1981

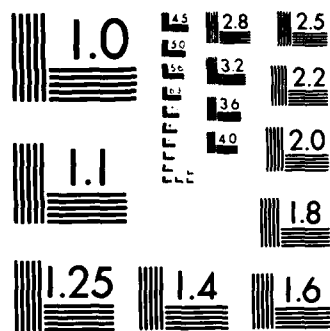
4/4

UNCLASSIFIED

F/G 1/3

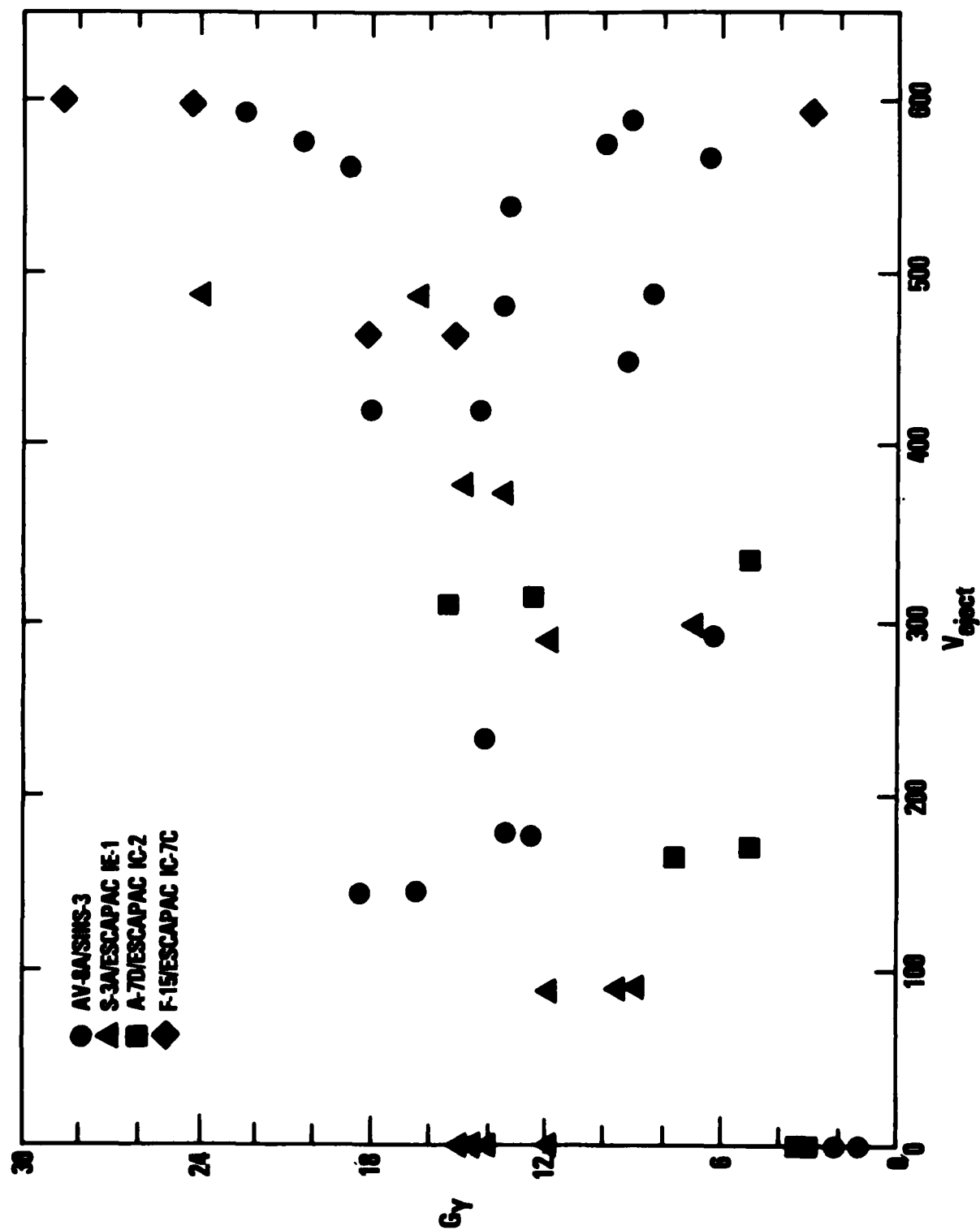
NL



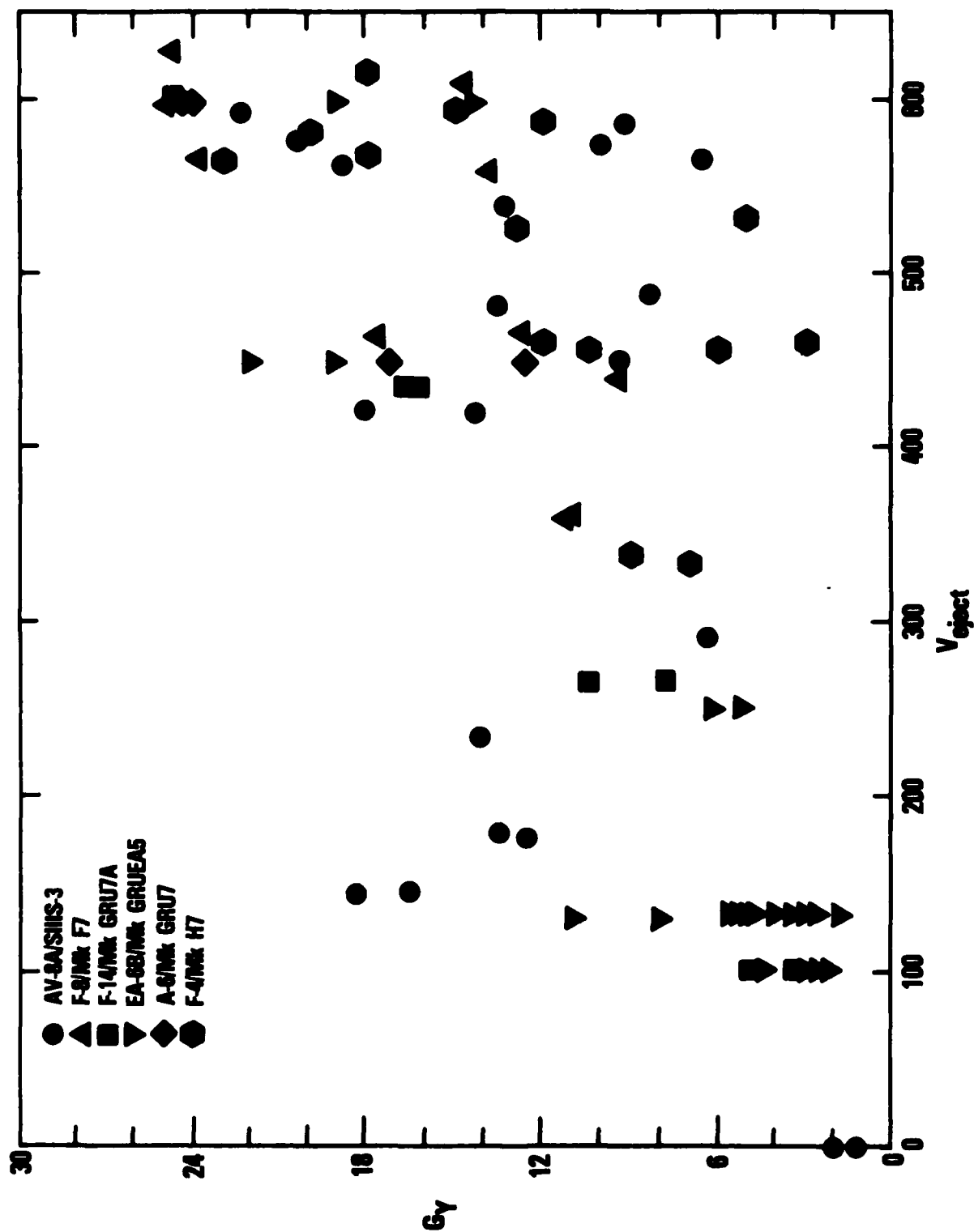


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LATERAL ACCELERATION COMPARISON

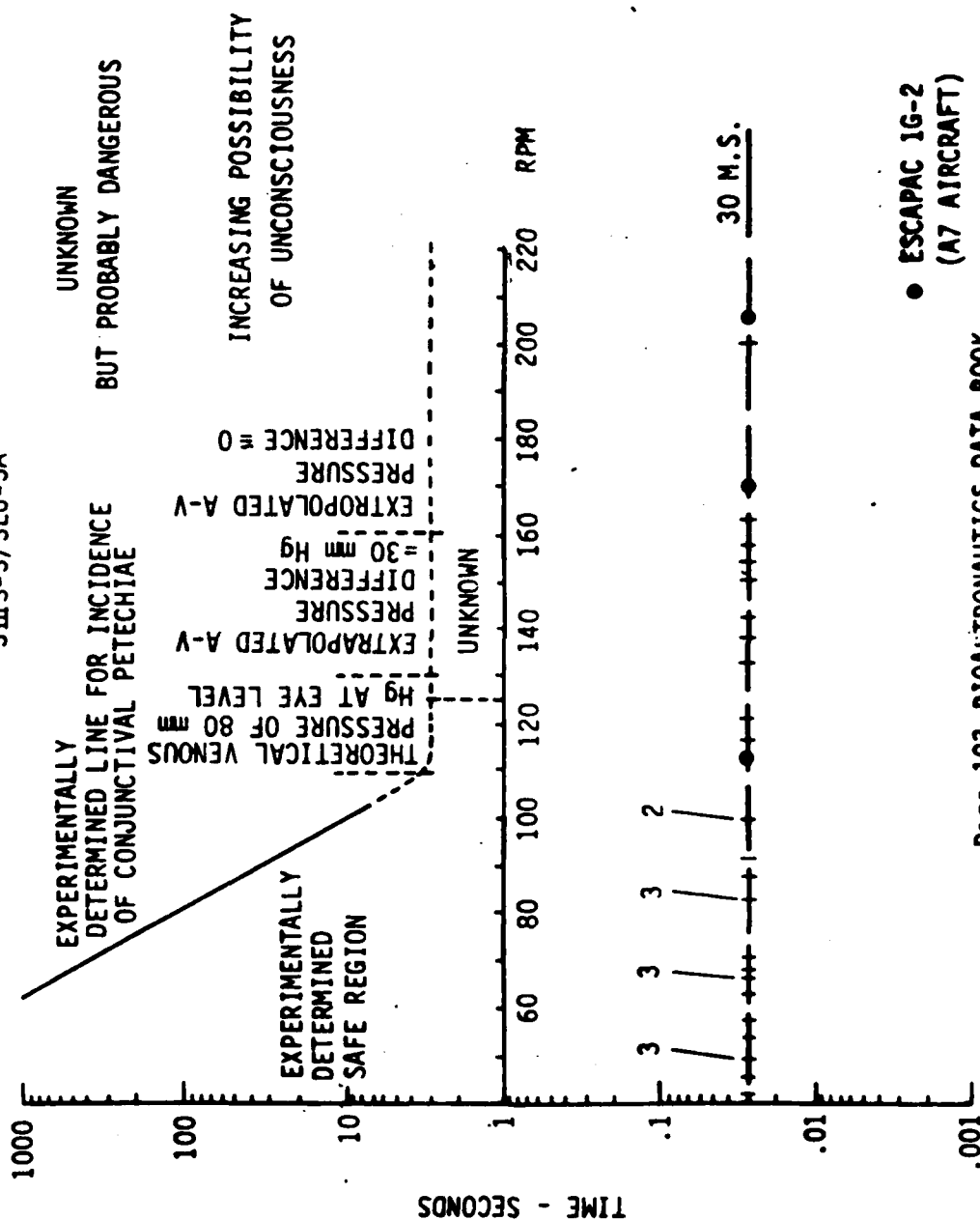


LATERAL ACCELERATION COMPARISON



PITCH ROTATIONAL RATES

SIIS-3/SEU-3A



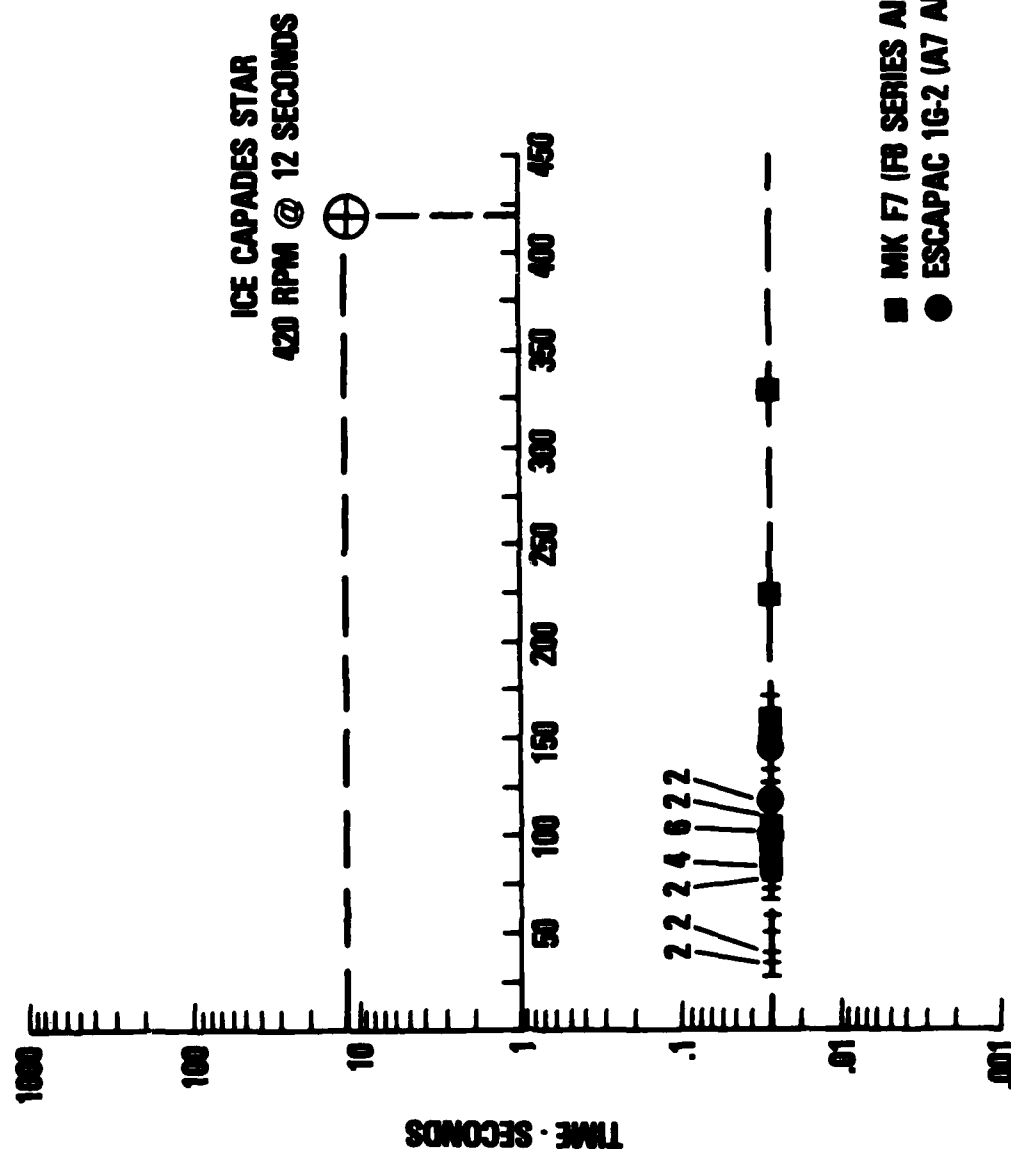
• ESCAPAC 1G-2
(A7 AIRCRAFT)

Page 193 BIOASTRONAUTICS DATA BOOK

J. F. Parker, Jr., Vita R. West

National Aeronautics and Space Administration 1973

YAW ROTATIONAL RATES **SIIS-3/SEU-3A**



"The phenomenon of epicyclic tumbling occurs primarily after emergency ejection from high-speed aircraft. Rates of tumbling as high as 200 rpm can be expected, and the winddrag superimposes a decelerative g field....These decelerative forces are dangerous if encountered alone, but, when superimposed on head-over-heels tumbling, the type of damage that results is qualitatively different from either the effects of deceleration alone or of tumbling alone or of a mere summation of these effects. For example, at 60 rpm in a 30g field, the force exerted on the body is 30g, the vector of this force changes direction by 180 deg every 1/2 sec, and the result is a severe, low-frequency vibration..."

Page 457

Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963

"The primary result of epicyclic tumbling, like that of vibration..., is mechanical damage to loosely suspended organs resulting from compression by the changing force vectors. Rigidly held organs are damaged less, and, for this reason, some amount of protection is obtained with abdominal compression produced by pressure suits."

"Animal data and the results of actual ejections indicate that moderate tumbling in a field of less than 15g is not dangerous. This phenomenon is thought to be due to the low-frequency response of the vascular (blood) column, which might suggest that tumbling is beneficial when deceleration occurs. It should be remembered, however, that the mechanical damage associated with tumbling is a more serious result. Thus, except for special instances, when high levels of deceleration are anticipated, stabilized ejection seats are recommended."

Page 458

Human Engineering Guide to Equipment Design
Morgan, Chapanis, Cook, Lund
McGraw-Hill Book Company, Inc.
1963

DURING WORLD WAR II, PILOTS OF AIRCRAFT
DISABLED AT HIGH SPEEDS EXPERIENCED
EXTREME DIFFICULTY EGRESSING COCKPITS
AND IN MANY INSTANCES WERE UNABLE TO
EGRESS DUE TO HIGH WINDBLAST LOADS.

THUS, INITIAL CONCEPTS OF EJECTION SEATS
WERE CONCERNED ALMOST ENTIRELY WITH
EGRESS ASPECT OF ESCAPE. ONCE CLEAR
OF AIRCRAFT EJECTEE PERFORMED MANUAL
BAILOUT FROM SEAT.

THESE INITIAL SYSTEMS PROVIDED VERY LIMITED ESCAPE CAPABILITY:

- WITH WINGS AND NOSE LEVEL AND NO SINKRATE MINIMUM REQUIRED TERRAIN CLEARANCE WAS 2,000 FEET.
- NONLEVEL OR SINKRATE FLIGHT CONDITIONS REQUIRED SIGNIFICANTLY GREATER ALTITUDES FOR SAFE ESCAPE.

BELOW SAFE EJECTION ALTITUDES PILOT WAS FORCED TO RELY ON CONTROLLED DITCH/CRASH OF AIRCRAFT.

MOST EARLY EJECTION SEATS, INCLUDING THOSE IN EARLY A-4 AIRCRAFT (PREDECESSOR TO ESCAPACs), TREATED THE PARACHUTE AS PART OF CREW'S EQUIPMENT EVEN THOUGH STOWAGE SPACE WAS PROVIDED.

FOR SAFE PARACHUTE OPERATION FOLLOWING ESCAPE FROM AIRCRAFT EJECTEE HAD TO:

- UNBUCKLE FROM AND PUSH CLEAR OF SEAT
- WAIT TO ASSURE SUFFICIENT SEPARATION FROM SEAT
- MANUALLY ACTUATE RIPCORD TO OPEN PARACHUTE PACK.

FAILURE TO WAIT OFTEN CAUSED SEAT-PARACHUTE AND/OR SEAT-MAN INVOLVEMENTS GENERALLY RESULTING IN DEATH OR SERIOUS INJURY.

TIME FROM ESCAPE INITIATION UNTIL EJECTEE WAS DESCENDING UNDER FULL PARACHUTE WAS EXTREMELY VARIABLE DUE TO DEPENDENCY ON MANUAL OPERATION BY MAN IN HIGH STRESS SITUATION/ENVIRONMENT.

FATALITY RATES AMONG EJECTEES NEAR OR BELOW SAFE LIMITS, AMONG CREWS ATTEMPTING DEADSTICK LANDINGS FROM BELOW EJECTION LIMITS, AND AMONG CREWS UNABLE EITHER TO EJECT OR CONTROL AIRCRAFT, RESULTED IN ATTEMPTS TO IMPROVE ESCAPE ENVELOPE. OF PARTICULAR CONCERN WAS THE LACK OF COVERAGE FOR CRITICAL LAUNCH AND RECOVERY PHASES OF CARRIER OPERATIONS.

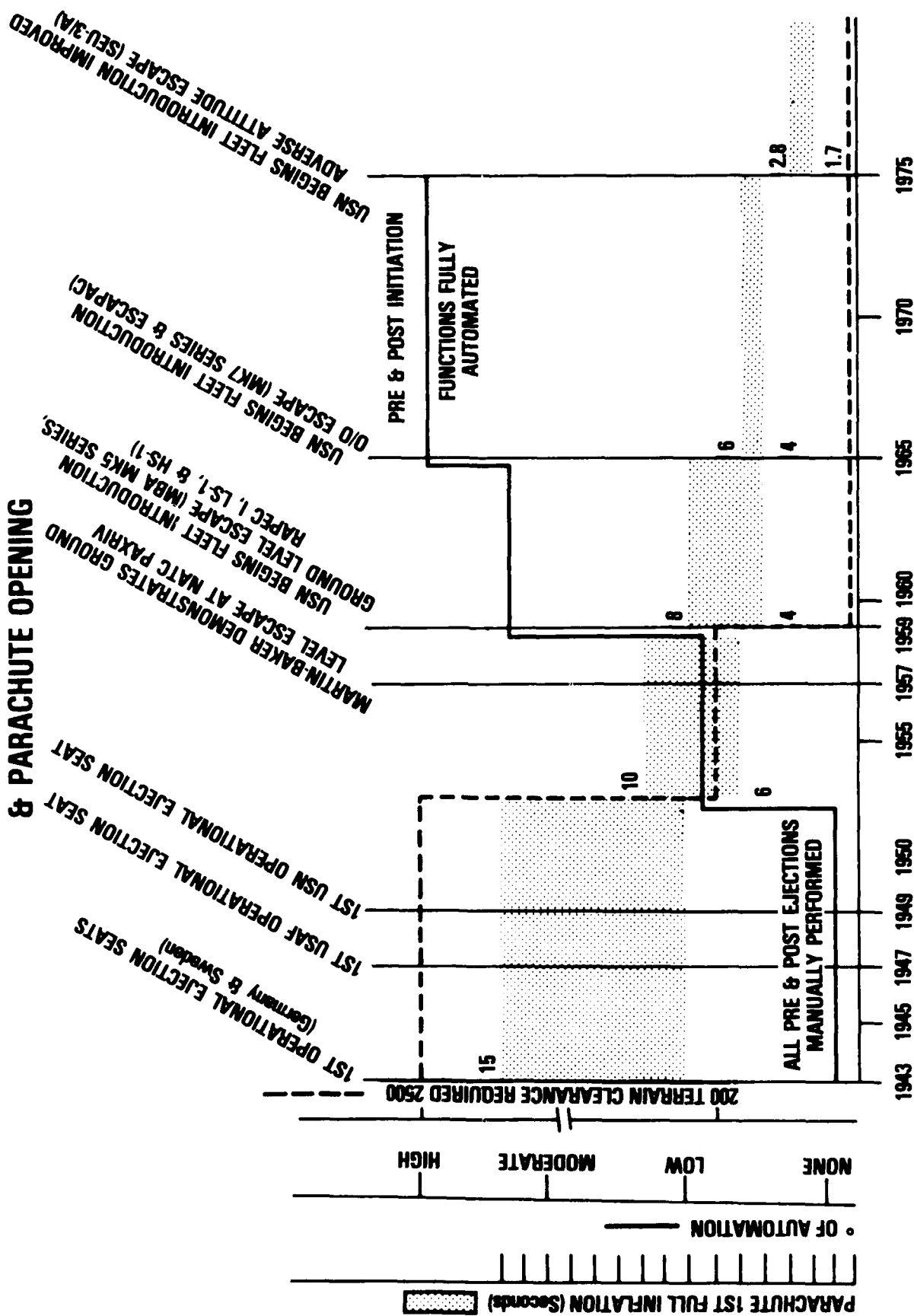
INITIAL PERFORMANCE IMPROVEMENT EFFORTS WERE AIMED AT REDUCING TIME AND UNCERTAINTY ASSOCIATED WITH MANUAL FUNCTIONS BY AUTOMATING THEM.

BY MID- TO LATE-1950's 200 FOOT WINGS/NOSE LEVEL NO SINKRATE ESCAPE WAS BEING ACHIEVED. BETWEEN LATE 1958 AND EARLY 1962 USN UNDERTOOK BOTH MAJOR UPGRADING AND REPLACEMENT ACTION TO OBTAIN GROUND LEVEL ESCAPE CAPABILITY. HOWEVER, THIS DID NOT COVER LAST STAGES OF LANDING OR INITIAL AIRBORNE PHASE OF TAKE-OFF.

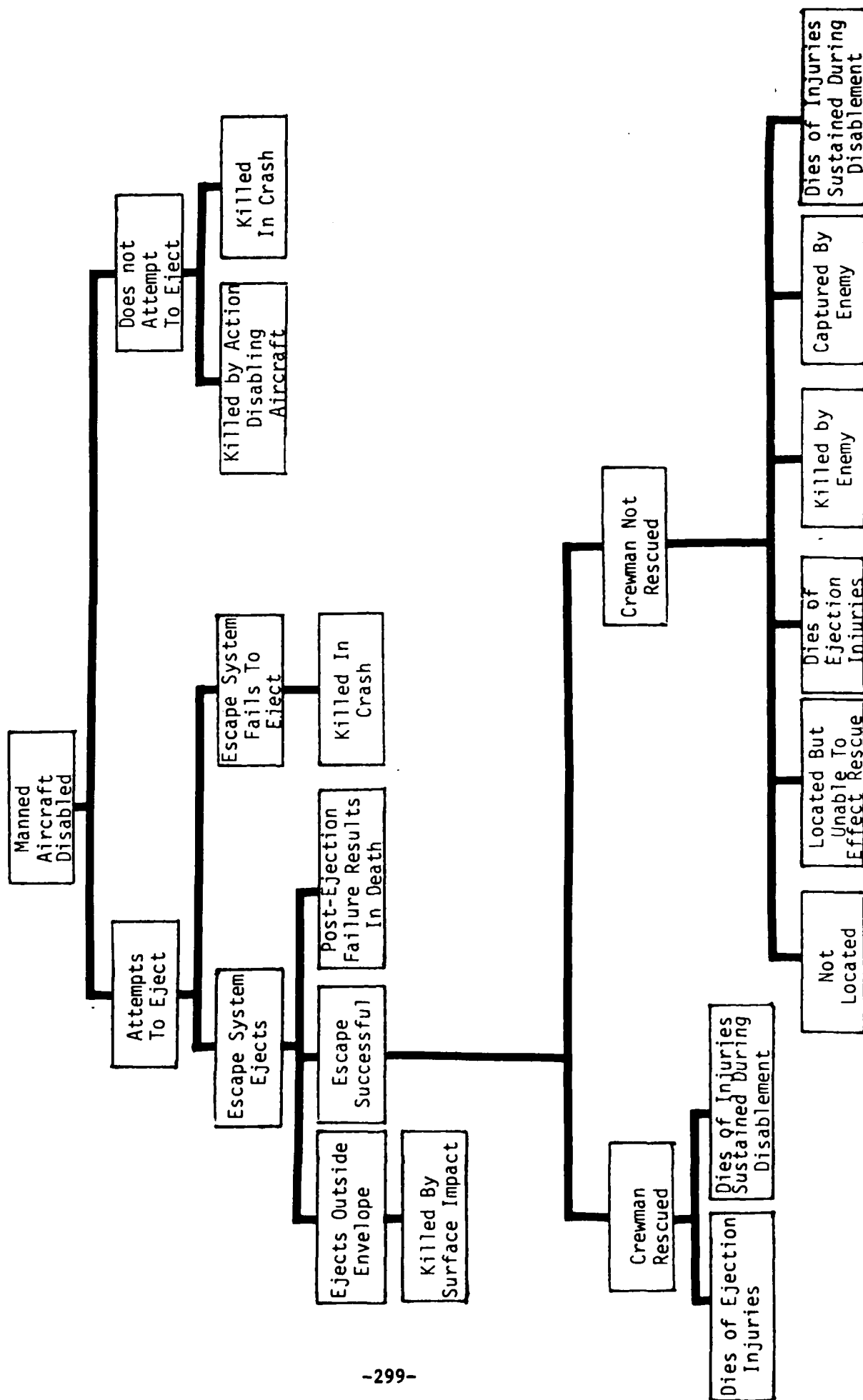
DURING MID- TO LATE 1960's, IN ATTEMPT TO FURTHER
REDUCE ALL AIRBORNE EMERGENCY-CAUSED FATALITIES,
ZERO-ZERO (0/0) ESCAPE WAS OBTAINED THROUGH MAJOR
MODIFICATION PROGRAMS.

PRIMARY PROBLEM SEEN IN OBTAINING 0/0 WAS TO
OBTAIN SUFFICIENT TIME FOR PARACHUTE OPERATION
SINCE ACCEPTABLE MEANS FOR SHORTENING PARACHUTE
OPERATING TIMES DID NOT EXIST. THEREFORE PRIMARY
APPROACH USED WAS TO CHANGE PROPULSION (INTRODUCE
ROCKETS) TO OBTAIN GREATER TRAJECTORY HEIGHT.

EJECTION SEAT HISTORY HIGHLIGHTS



CAUSES FOR AIRCREW LOSS



IMPROVED EJECTION ENVELOPE BENEFITS

- ESCAPE AVAILABLE FOR MORE AIRCREW (I.E. THOSE ENCOUNTERING LOW LEVEL EMERGENCIES REQUIRING ESCAPE).
- MORE TIME AVAILABLE TO AIRCREW FOR PROBLEM DIAGNOSIS AND SOLUTION.
 - POSSIBLE INCREASED SAVING OF AIRCRAFT

END

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